THE

Practical Teacher

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'*Knowledge is proud that he has learned so much,*
Wisdom is humble that he knows no more.'—COWPER.

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Hygiene.

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WATER—(*Continued*).

Metals.—The next point of importance is to detect the presence of the poisonous metals. These are lead and copper. Some chemists prepare standard solutions, containing a minute proportion of each (one milligramme of a copper salt, being dissolved in one cubic centimetre of distilled water), and then comparing the behaviour of the suspected water with the standard solution. Iron may be detected in the same way. The addition of solution of sulphide of ammonium dropped very carefully into a sample of the water contained in a dish of white porcelain, gives a dark colour. It should be well stirred and then compared with the standard solution. A standard lead solution requires 1·66 grammes of acetate of lead in a litre of water. Copper requires 3·92 grammes of the sulphate, and iron should have 4·95 grammes of pure protosulphate of iron in one litre of water. If a dark liquid is formed when the $(NH_4)_2S$ is added, the colour will disappear if it be iron, on adding a few drops of dilute HCl. If it does not disappear it is either lead or copper; $\frac{1}{10}$th of a grain can be thus detected in a gallon of water, and if the colour is persistent after the acid is added, the water should be condemned as not fit for drinking purposes. **As.** may be present by accident or design, and if suspected the water should be rendered alkaline by sodium carbonate, and then concentrated by being boiled down to $\frac{1}{50}$ of its bulk; then acidulated with HCl, and examined by means of Marsh's apparatus. This is an apparatus for generating hydrogen gas. It consists of a small flask containing pure granulated zinc and some water. There is a glass funnel-tube passed through the cork, and also an exit tube bent at right angles and drawn out to a point. Some H_2SO_4 is poured into the apparatus through the funnel. H. is immediately set free. It should be tested by lighting it at the bent exit tube, and allowing the flame to impinge upon a white porcelain slab. If **As.** is present there will be a brown spot deposited on the porcelain. If it be unstained the suspected water should then be added, and the gas again tested in a similar manner. The **As.** if present will be deposited on the slab. Antimony may be detected in the same way. The difference between the two deposits will be easily made out by using the tests which distinguish between the metals. In testing for poisons it is always necessary to examine the reagents employed before putting in the suspected liquids.

Total Solid Residue.—This is a simple operation in water analysis. Evaporate a known weight of the water to dryness. It should be performed in a platinum dish and then the whole weighed. If the weight of the dish be subtracted, the quantity of solid residue will be shown.

A gallon of water weighs 70,000 grains and 70 c.c. of water weigh 70,000 milligrammes. The number of milligrammes of solid residue will be the number of grains in the gallon, if 70 c.c. of water are evaporated to dryness. The residue is mainly carbonate of lime. This is proved by dropping a few drops of HCl upon it; an effervescence takes place. There may be some sulphate of lime, and also of magnesia, if the water is a hard water. If there be organic matter in the residue, this will be shown by its being blackened by ignition.

If the solid residue does not exceed 30 grains per gallon, it is not excessive. The water supplied to London by the London Water Companies contains 18 to 20 grains per gallon, whilst the Manchester supply has less than 5, and the Glasgow under 3; ordinary sea-water contains about 2685 grains in the gallon.

Hardness.—This is an important point to be determined. The quantity of solid residue gives an approximate idea, but the actual state of the case is obtained by the use of the soap test. Taking a standard soap solution which contains exactly sufficient soap to precipitate one milligram of carbonate of lime in each cubic centimetre of the water, there will be a frothing in the water after the carbonate of lime is neutralised. A common half-pint bottle may be taken, and into it put 70 c.c. of the water to be examined, and then add a few centimetres of the test solution, and shaking after each addition. If there is no froth, continue to add smaller quantities until saturation is reached. The number of centimetres of the solution which have been added will indicate the number of

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grains of lime in each gallon of the water which is under examination.

The standard solution is made by taking 10 grammes of castile soap and dissolving it in a little weak alcohol, and then testing with a known solution of lime in water until the strength of the soap solution is obtained. (Mem. : a gramme equals 15·43 English grains, and a litre is 1·76 English pints.)

The hardness of a water is described as being of two kinds, the temporary and the permanent.

If water is boiled for some time, it deposits more or less of the carbonate of lime, which exists in solution as a bicarbonate, which salt is unstable at 212° F. Boiling softens water by driving off one atom of the CO_2, and by that means the carbonate not being soluble is thrown down. The salts left in solution are the sulphates and the chlorides and the magnesia salts, which are the causes of the permanent hardness of the water. The results, especially as regards the magnesia salts, are approximative only, but they are of considerable assistance in arriving at the potability of a given water-supply. If the permanent hardness shows a residue of 8 or 9 grains per gall. it is not a good potable water.

Hard water may be softened by what is called *Clark's process*, which at the same time assists to purify it, by throwing down organic matter which may be in solution or suspension in the water Milk of lime is added until the excess of CO_2 in the lime salt is neutralised, and the whole is precipitated as a monocarbonate. It is a very easy process, and can be carried out without entailing any great expense, even in private houses, whilst the advantage of using softened water for dietetic and washing purposes must be manifest to all. The only important point is to get an accurate analysis of the water, showing how many grains of lime there are in each gallon, then find how much milk of lime is requisite to be used until a sample of the water gives a brown precipitate with a solution of nitrate of silver, instead of the white precipitate which ordinary hard water produces, and a simple sum will tell how much lime-water must be used for each 1000 gallons of water to be softened.

The precipitate soon deposits, and the clear, supernatent liquid should be syphoned off.

The total hardness of a water divides itself, therefore, into the temporary or removable, and the permanent or fixed hardness. The major portion of the temporary hardness is removed by the softening process as well as by continued boiling.

Phosphoric Acid and *Phosphates*.—The presence of these salts are evidences of serious contamination. Incinerate the residue left after evaporation, and add a few drops of HNO_3, and a little water, then filter. The filtrate should then be mixed with an equal quantity of solution of molybdate of ammonium. There will be either colour, turbidity, or definite precipitation, according as there are traces or more distinct evidence of the presence of H_3PO_4 in the water. The presence of distinct traces of H_3PO_4 is indicative of sewage contamination.

Oxidisable Matter.—This may be qualitatively determined by the use of potassium permanganate. It is a rough-and-ready means by which bad water may be rapidly condemned, but it does not follow that water which stands the test is fit for use. The colour of the solution is discharged more or less rapidly according to the quantity of oxidisable matter in the water, and calculations are made as to the quantity of oxygen which the permanganate provides and which is required for oxidation. The permanganate process does not act upon many substances, such as starch, urea, sugar, or gelatine, and is not in itself sufficient to prove a given water to be pure.

About half a litre of the water to be examined should be acidulated with a few drops of HCl and a solution of permanganate of potass of such a strength that ten minims should contain $\frac{1}{100}$ of a grain of oxygen. So long as the colour is discharged there is oxidisable matter. As soon as the colour produced by the addition of the salt fails to be bleached the limit is reached, the quantity of oxygen required is known and the amount of contamination may be easily calculated.

Water Filters.—Water is purified on a large scale by the London and other water companies by means of large filter-beds made up of a series of layers of coarse gravel, fine gravel, and sand. It is found in practice that there is a limit as to quantity, which filters must not be allowed to pass, and that a bed will not purify more than 700 gallons per square yard in the twenty-fours hours, unless the filtration is frequently intermitted so as to allow of aeration of the filter, and of the removal of the thin deposit of matter which is found upon the surface of the sand, if the water contains a perceptible amount of impurity. A properly constructed filter will purify for a short time only, it will remove matters in suspension for a much longer period, but it will not oxidise or destroy organic matters in solution unless the process is very frequently intermitted.

The action of a filter on a large scale can be mechanical only, for if the water is so impure as to be unfit for drinking purposes in consequence of the organic matter in solution before filtration, it will not be made potable by simple filtration through sand, unless the process is very slowly conducted, and the thickness of the filtering medium many yards instead of the few feet which is generally provided.

The best filtering mediums for small filters are all liable to foul from continued use, and should never be trusted for anything more than temporary purposes. Animal charcoal properly washed is the best, but the silicated carbon filter is capable of acting equally well with animal charcoal, the patent carbon filter of Atkins and Co., and other forms of charcoal filters. Dr. Parkes was of opinion that the only efficient filters were those made of magnetic carbide or animal charcoal, but filters of all kinds are only temporary means for purifying water. The charcoal after use for a few weeks should be purified by exposure to the sun and air, or else be placed in a furnace until it has been completely heated to a temperature of 300 degrees. Water which has been boiled for some time is both purified and softened, which action will be much more efficient than any filter in removing obnoxious matter from the water. It acts much in the same manner as Clark's process for softening, that is, it removes the extra atom of CO_2 and coagulates any albuminous organic matter which may be presen'. Alluminous salts are used in Eastern countries for the same purpose. Potassium permanganate or Condy's red fluid will remove smell from water, but will not precipitate the albumen.

Quantity of Water required for Domestic Use.—The London companies supply from twenty to thirty-five gallons per head per day for all purposes. The

town of Croydon has thirty-five gallons; some towns are content with twenty gallons, whilst others have thirty gallons. For ordinary domestic use twenty-five gallons will be ample, viz., ten for house consumption, five for baths, six for W.C.s, and the rest for waste, which is more or less unavoidable. Hospitals should have not less than thirty-five to forty gallons per head, but in prisons and other places under complete control of responsible officials it is found that twelve gallons per head per day gives a good allowance.

Kind of Service.—Water from surface-wells is sure to be contaminated at all times if they are situated in populous districts, whilst that from deep wells and borings, if preserved from surface pollution, will chemically vary only according to the geological character of the collecting ground and the nature of the strata from which it is obtained.

Artesian Wells are those wells of greater or less depth in which there is a collecting ground at a higher level than the site of the well, and which is some distance, it may be one hundred miles, from it; the water is kept down by a superincumbent impervious strata, which being designedly pierced, allows the water to rise directly to the surface without the necessity for pumping power. All towns of any size are now supplied by waterworks, the water being obtained from mountain-streams, rivers, lakes, or artificial collecting-grounds, and conveyed to the place of distribution by iron pipes. Storage works are necessary, according to the requirements of the situation.

Reservoirs may be open or covered according to the character of the neighbourhood, but they must be preserved from contamination as well as the wells and streams. They should be so situated as to command the town to be supplied, so that the water may run down by gravitation for the purposes of distribution, so as to avoid, if possible, the expense of pumping. The mains are of cast iron. They are generally coated inside with pitch to preserve them from the corroding action of gases and some salts which are found in almost all waters.

It should be the custom to avoid having dead ends in main water-pipes; that is, there should be a circulation round and round so that the water should never have the opportunity of becoming stagnant. A service is said to be *constant* or *intermittent*, according as to whether the supply is drawn direct from the main, or is first conducted into a cistern. A constant service is much more likely to be a pure service if the supply is pure to start with, for intermittent supplies are much more liable to contamination, either by means of the cistern fouling, or in consequence of the pipes becoming exhausted, and allowing of the regurgitation of foul matters into an exhausted receiver. Service by means of cisterns is not a good service; it is wasteful also, and the water is so liable to contamination, that cisterns should not be tolerated except in connection with the w.c. No w.c. should be allowed to draw its flush of water direct from the main, because there is a danger in the plan which cannot always be averted. It is the custom to use a so-called water-waste preventive cistern holding two or three gallons of water, and which is discharged every time the closet is used. The best kinds of water-waste preventive cisterns may be seen in action every day at the Parkes Museum, 74a, Margaret Street, London. All students who are getting up this subject should visit that depôt and see the machines in operation, and make themselves acquainted with their details by actual inspection. The Museum is open daily free of charge. All kinds of fittings connected with water-supply are to be seen there, the best way of arranging for water-supply to baths, closets, urinals, and lavatories are also to be seen and should be personally inspected. No water for potable purposes should ever be drawn from a w.c. cistern.

The house fittings are generally of lead; but in those towns in which the water-supply is very soft lead is not admissible. The bicarbonate of lime allows the pipes to become coated with an insoluble carbonate of lead which protects the metal from further action. If the water is very pure, the lead is dissolved by it, and carbonate of lead itself may be taken up, whilst if the water contains any quantity of nitrates, these attack the lead and cause much mischief if the use of such water is continued. It does not answer to store rain-water in lead cisterns for the same reasons. Slate makes the best storing medium; care must be used also not to allow of leaden covers even when the water is hard, as the heat on a summer's day tends to a good deal of condensation of distilled water upon the metal, which, having dissolved some of the lead, will drop back again into the cistern and contaminate the whole supply. Iron fittings are more advantageous as being less liable to derangement and rupture in frosty weather. It is curious to note the great inattention which is paid by plumbers to the possibility of frost. The pipes which convey water into a house are generally so placed that the water must freeze in them whenever the temperature sinks for any time below the freezing-point. Water-pipes should always be protected from the effect of cold, and an arrangement should be made by which they may be emptied in frosty weather, so as to obviate this risk, and then the mischief which follows upon a thaw may be altogether prevented.

(To be continued.)

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The New Class-Subject, 'Elementary Science.'

(What to teach, and how to teach it.)

BY RICHARD BALCHIN.

THE facts, and the methods of presenting them, for the lessons included in Chapters V. to XIV. are given with sufficient fulness in the 'Science Reader' for Standard IV.

I now pass on to the series of lessons in connection with Chapters XV. to XVII. These deal with the classification of the sub kingdom, 'vertebrata' or backbone animals. It has always appeared to me that the subject of Natural History or rather 'zoology' has been very imperfectly treated in our schools. It is true, we have a plentiful stock of pictures and illustrations; and lessons on 'animals' are common enough, especially in the lower standards. But these lessons have invariably taken the form of anecdotal descriptions of the appearances, habits, and uses, of certain members of the animal kingdom. Moreover, in the case of such lessons, I have never been able to detect a plan or system. One day we have a lesson on the 'elephant,' then on the 'salmon,' followed by one on the 'eagle,' and so on; and this is the case, not with the lower standards only, but also with the upper ones. We

never get to what I may call the 'biology' of the subject. We never touch the *science* of animal life. And yet we live in the days of a Darwin and a Huxley. 'What *is* a fish?' 'In what respects does a bird differ from a bat?' are questions which could not be answered by one in a hundred of the boys in even our upper standards—boys who probably find their class-room walls adorned with very beautiful pictures of these and other creatures.

In the series of simple lessons I am now about to describe, this defect is sought to be remedied. I am of course perfectly aware that we cannot conveniently include in our lessons the very foundation of all biological knowledge; I mean dissections and microscopic work in connection with cells, vessels, tissues, etc.

What I think *may* be done in Standards IV. and upwards is as follows:—

First, to make as clear as possible the distinction between the vertebrata and invertebrata.

Second, to begin with the vertebrata, as being the easier of treatment and more within reach, and explain the basis of our classification of this sub-kingdom.

Third, to classify the vertebrata into (*a*) fish, (*b*) amphibians, (*c*) reptiles, (*d*) birds, (*e*) mammals.

Fourth, leaving out of consideration the skeleton, to take the organs engaged in respiration and circulation, the skin and its covering, the mode of bringing forth the young, and to show in an elementary fashion the gradual advance in structure of such organs, from the lowest fish (the lancelet), to the highest mammal (man).

Fifth, to show that the five classes of vertebrates have appeared one after the other, in successive geological periods. I mean that there first of all came upon the scene 'fish.' That is to say, there *was* a time (the silurian age) when fishes were the only vertebrate animals tenanting the globe. On the dry land there were as yet no members of this sub-kingdom. Afterwards (the beginning of the carboniferous age) amphibians put in an appearance. They came up out of the waters. At this time, fish and amphibians were the only vertebrates terrestrial. Then there followed (in the Permian age) reptiles; these probably had dominion over all the others. We reach birds, in the next age; and, lastly (in the new red sandstone), we can just detect the dawn of mammalian life. Of these, the first to appear are among the lowest in the class—opossum-like creatures; and the last to appear is that most highly organised mammal, man himself.

At this point in my article, the reader will probably throw down the book and cry, 'Impossible!' 'Can't be done!' 'Flat evolution!'

Now it *can* be done, because I have *done* it. And as for evolution, I never so much as mention the word to fourth-standard boys. What I certainly *do*, with respect to this great law, is to lay before the scholars a series of facts which shall prepare their minds to grasp and accept this wonderful discovery respecting life-progress.

It is to me quite delightful to watch the attentive and sparkling eyes of some of the boys. These youngsters are greedily devouring—if I may so speak—the facts, which are to them all so novel. A few days ago, in one of my lessons, I was just glancing at the heart-development as it is exhibited in the five classes of the vertebrata. Of course this was done in a very elementary fashion. In the lowest fish—the lancelet—there is a series of pulsatory swellings of the main blood-vessel; each swelling answering to a heart of *one* chamber. I illustrated its action by alternately squeezing and relaxing a piece of india-rubber tube, and so propelling water along it. In the vast majority of fishes the heart is of *two* chambers; I described them and their action. In the amphibians (*e.g.*, a frog) the heart is first two-chambered, like a fish; afterwards three-chambered, like a reptile. In the lower forms of reptilian life the heart is of three chambers, but with a sort of incipient division appearing in the one ventricle; and this division is, in the highest of the reptiles, quite complete; and *their* heart is four-chambered, like that of birds and mammals. The boys were quite able to follow me as I drew roughly on the blackboard, diagrams of these progressively-organised means of circulation. Surely this definite, scientific teaching, although, I admit, it was of necessity almost painfully elementary, is yet worth all your anecdotes and legends about animals.

The following are outlines of lessons in this series, which, perhaps, it would be as well if I numbered separately from the others in the course for Standard IV.

LESSON I.

VERTEBRATA AND INVERTEBRATA.

Some animals *with* backbones; fish, snake, dog, etc. Some animals without backbones; worm, oyster, etc. Show backbone or part of one, of fish or rabbit; not one piece, several pieces. String together a number of empty reels (cotton reels) as an illustration; or, better still, get the boys to bring a number of india-rubber rings, such as are found in the necks of a certain kind of lemonade bottles: glue the reels together with the indiarubber rings between: this gives a flexible column. The reels represent the vertebræ, and the rings the vertebral cartilage. (*Note.*—One of the boys, seeing his teacher construct such an illustration of the backbone, made one himself at home; but added something which I thought very ingenious. He passed a length of worsted from a ball of worsted down through the holes of the reels, leaving the remaining unrolled portion of the ball at the top of the column. The worsted, passing down the channels of the reels, represented the spinal cord, and the ball in connection with it, the brain. The only defective part of the boy's illustration was that the neural canal would appear to pass through the centrum of each vertebra, which, of course, it does not.)

Each piece of the backbone is a vertebra, hence the whole is called the vertebral column. All animals with such a bone are vertebrate animals. 'In' means 'not.' All animals without such are invertebrate animals. Describe more fully this vertebral column and its appendages, as figured on page 56 of Science Reader for Standard III.

LESSON II.

CLASSIFICATION OF SUB-KINGDOM 'VERTEBRATA.'

Recapitulate the ideas respecting classification in general as given in the 'Reader' for Standard III. Lead up to just such a classification of vertebrate animals as I have found generally suggests itself to boys. Namely:—(1) animals that fly; (2) animals that have to keep to the ground; (3) animals that swim. In other words, *birds, beasts, and fishes.* Show, by a string of questions, the defects of such a classi-

fication. Thus:—Where should we place the emu? It cannot fly, and yet is a bird, Or the bat? It *can* fly, and yet is *not* a bird. Or the whale? It lives in the water, and yet is not a fish. So lead to the conclusion that to take the *habits* of the animals as the basis of our classification is not satisfactory. Now show the school-picture (Murby's set) of the organs of the human body, and of a fish. Explain 'organ'; and describe briefly the functions of the heart and lungs. Compare lungs with gills. Lead up to the conclusion that a better basis for our classification than the 'habits' of animals would be the build or structure of the chief organs: in short, 'organization.' Taking the latter as the basis, we divide the vertebrata into five classes:—(1) Mammals; (2) Birds; (3) Reptiles; (4) Amphibians; (5) Fishes. Show—in a very general way at present—the manner in which the animals in these classes differ with respect to (1st) the circulation; (2nd) the respiration; (3rd) the skin covering; (4th) the manner of birth.

Note.—I generally find it necessary to devote two lessons to this subject, which, I may add, is an extremely interesting one to boys, although, at first sight, it may not appear to be so.

(*To be continued.*)

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Article 106 (*b*).

Merit Grant in Infant Schools.

BY MRS. MORTIMER,

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Section II.—Phenomena of Nature.

LESSON—THE SNOW.

Now, children, we have had a talk about rain, and you can tell me which time of the year we like rain. In the summer-time. When else do we have rain? All the year round. Yes, it rains both in warm and cold weather. There is something else that falls from the clouds besides rain, and it only falls in cold weather. Can you tell me what it is? It is snow. Well, I want you to tell me all about the snow. It is white and soft. Yes, and does it come down like the rain? No, the snow does not fall at once. What do you mean? The pieces of snow seem to fly about after one another and then fall. What do we call the pieces of snow? Flakes. Yes, look now at the flakes of the snow—they seem to be chasing one another. How does the snow look when it is on the ground? Very pretty, and on the trees it looks prettier still. Yes, when it has been snowing all the things are white, and if the sun shines through the trees you will see the pretty glitter on all the branches. Do you like to go out when it has been snowing? Why? To play with it. What do you do? Make snowballs and throw them about. What do the big boys do? Sometimes they make snow men, and sometimes they roll a large ball over and over until it is so large that they cannot move it. How does it make your hands feel? At first very cold. Yes, but if you run about you soon get warm. What ought you to do after you have been out in the snow? If you look at your boots what do you see? Yes, they are wet and this wet goes through your boots to your feet, and if your feet are wet what generally happens? We catch cold. Yes, unless you take your boots and socks off and rub your feet well.

Some little boys and girls do not like feeling so cold, so they bring the snow to the fire. What happens then? The snow melts. What do you mean by that? The snow turns into water. What makes the snow melt? The fire. You see then, if you want to play with the snow you must not mind going out in the cold. And if you put your thick coats and scarves on and run about you will get warm. Sometimes after it has been snowing the weather keeps very cold, and then what happens to the snow on the ground? It gets very hard, and we can walk on it without sinking into it. What happens to you then? We sometimes fall down. How is that? The snow is slippery like ice. What do the big boys do? They run along and slide over the snow. The teacher might here show a picture of a sleigh, and describe what fun the boys have in very cold countries, and how the snow helps the people to get about from place to place.

Sometimes when it has been snowing all day you go to bed and think you will have such fun in the morning with the snow—then when you get up and look out of the window you see the sun shining but no snow. How is that? Where has it gone? It has thawed. What do you mean by that? How does the snow look when it thaws? It looks very dirty and makes the roads very muddy. Who clears away the dirty snow? Yes, you see men and boys with brooms and shovels. They knock at the doors and ask the people inside if they want their paths cleaned. What must you give these men or boys? Some money. If the snow has been on the ground some time and been walked on it is very hard to clear away, but if it has only just fallen it is easily swept away.

How can we tell when we are going to have a snow-storm? The clouds are very thick and dull and it feels very cold. What do we generally get from the clouds? Rain. Yes, but sometimes when it is very cold, before the clouds turn into rain, they become frozen and in this way the snow is formed. You will have to learn more about this when you are older. You have never thought that the snow is very useful, have you? Well, when the snow falls it keeps the ground warm, and the plants that are in the ground are then able to stand the hard frost. If the plants were frozen they would die. Then when the snow melts the water goes into the ground, and this gives the plants food, and makes the ground better for the flowers, etc., that grow in the warm weather.

Section III.—Common Employments.

LESSON—THE POSTMAN.

Now, children, we are going to talk about the postman. Who is the postman? The man who brings us letters. How do you know a postman? By his dress. Tell me what kind of clothes he wears. He has dark-blue cloth clothes with a little red on them. Where is the red? His trousers have a red stripe on the outside. Then he has some on his coat-collar and also on his coat-cuffs. What about his hat? He wears a peaked cap, and this also has some red on it. Have you not seen something else on his cap? Yes, there are some letters and figures. Who can tell me what letters are on the postman's cap? He has G.P.O. on it. I do not expect you know why the postman has these letters on his cap, so I will tell you. There is a very large post-office called the General Post Office, which is the largest in England. He has these letters to show that he belongs to the General Post Office. Then the postman has letters on his coat-collar. Have you ever noticed any? Sometimes you will see N., sometimes S., sometimes E., and W., and a few others. Who can tell me what these letters mean? That is quite right, N. stands for North, S. for South, E. for East, and W. for West. The postman who has N. on his collar takes the letters to the north of London, the one that has S. has to go to the south of London, etc.

London is divided into ten parts, and there are different postmen for each part. Now tell me how many different sets of postmen there are? Ten. How many letters did we say? Four. What were they? North, South, East, and West. Yes; then how many more do you want? Six. We will write the letters on the slate, and another day you must try to learn all about them. The letters are N.E., S.E., N.W., S.W., W.C., and E.C.

What does a postman carry with him? A bag. What does he put in the bag? The letters, and he generally

has one packet in his hand. What does he do with them? He leaves them at the different houses. How do you know when the postman comes to your house? He gives a postman's knock. Show me how the postman knocks? Yes; it is quite different to any other knock. What kind of knock do you call it? A sharp double one. How does the postman walk along? Very quickly. Why? Because he has a great many letters to leave, and he must make haste, for we do not like our letters to be late. Has the postman any other work to do besides going out with the letters? What is it? He goes to the letter-boxes to collect the letters. Where are the letter-boxes? In the streets. What are they like? Large red round posts, with a hole near the top to put the letters in. How does the postman get them out? He opens a large door, and then they fall into his bag. Does the postman get the letters from any other place? Yes; sometimes the postman goes to the post-offices. Where are they? At different shops. What kind of shops? Stationers', grocers', and tobacconists'. Yes; then there are the large post-offices that are only used for post-offices. There is one of these large post-offices in each district in London. How many districts did we find out? Then there are ten District post-offices, besides that very large one I told you about. What is that called? The General Post Office. Now, you said the postman collects the letters. What does he do with them? He takes them to the district office, and there the letters have to be sorted. What do I mean by sorted? Yes, that is right; a great many people put their letters into the post, and they are sent to different places. Now, the postman could not take them all to their right places. Why not? Because he would be too long, and he would be tired. So the letters are sorted. All the letters for London in one place; those for different parts of the country in others, and so on. Those for London are sorted for each district, and the postman has the letters for a few streets only given to him. Before they leave the office they are marked so as to show they have been through the post-office. The country letters are packed in sacks, and carts take them away. Who has seen the post-office carts? What colour are they? Do you know what we call them? We say they are mail carts. Where do you think the mail carts take the letters? To the railway station. Yes; and they are taken into the country by the train. Some of these trains are called mail trains, and there is a separate carriage for the letters. If you were to peep into one of these carriages you would see the postmen sorting the letters. When they come to the stations they leave the letters for that part of the country, and then get the next packet ready; so you see these men are very busy. Do you know how they fasten the bags? Yes; with a piece of string. They also put some sealing wax on them and then stamp them.

Do you know who is the postman's master? That is right; he is one of the Queen's servants. I dare say you have seen something written on the letter-carts. What was it? Two letters, 'V.R.' Yes; and two words, 'Royal Mail.' These letters and words all show that they belong to the Queen.

Now I want you to tell me what kind of man the postman ought to be. He must be quick. Why? What else? What must he do before he takes a letter to a house? He must *read* the outside. Yes; we say he must read the address. Then if the people have moved away, he has to *write* something on the envelope. Do you know what he would write? He writes, 'Not known,' or 'Moved away.' Then you see a postman must be able to read and write. The postman has many letters to carry, and sometimes there are other things in the letters. Tell me something we send in letters. Money, pictures, etc. What kind of man must the postman be to have charge of these things? He must be honest. Yes; we have to trust him very much, but then we all must be honest. Cannot you think of anything else? He must be clean and very careful.

There are a few ways in which we can help the postman. Can you tell me any? What should we do when we hear the postman's knock. Run quickly to the door so that the man does not have to wait. Then you told me that he has to read the addresses on the envelope, so what should we do to help the postman? Write very plainly, and be very careful to put the right name of the street and the number of the house. Sometimes the house has a name instead of a number, and we must be sure to put the right name on the letter. How does the postman manage to read the addresses at night? He has a lantern. Yes; and this also helps him to see the numbers of the houses.

Section III.—Scenes of Common Life.

LESSON—THE RAILWAY STATION.

Apparatus: Picture of station, model showing railway and station with engine and carriages; a few tickets.

What part of the year do you have the longest holidays? What do you do in your holidays? Some of you play in the parks and in your gardens and some go into the country. Now I want those of you who went into the country for the last holidays to answer me and tell all the other little boys and girls about what they saw. How did you get into the country? Yes, you had to go in a train, and the train runs along the railroad. Can any of you tell me how the railroad is made? Of what is it made? Of long pieces of iron. Yes, these pieces of iron or steel are called rails. Teacher showing the model would direct the children's attention to the way the rails are laid on the long thick pieces of wood, and if a good model is being shown the shape of the 'chair' should be pointed out and the way the chairs are fastened to the 'sleepers' should also be shown to the children. The rows of rails are called lines. How many lines of rails do you see? Four lines. How many does the train run on? Two lines. For what are the other two? For the trains running the other way. Yes, it would not do for them to run on the same lines. Can you tell me what would happen if they were to run on the same lines? The trains would meet together. The teacher might here allude to accidents caused in this way. Where else do you see lines of rails? In the streets. What do you call them? Tramways. Do the engines go on them? No, the trams are pulled along by horses. The teacher might here show the advantage of engines to horses and also the danger of using them in the streets.

You have told me all about the railroad, and now I want you to tell me about the train. What is the first part of the train called? The engine. What does this do? It pulls the carriages along. Now look at the engine (picture or model to be shown); tell me some of the parts of it. The chimney, the boiler, the tender, the large fire. Yes, you see there is smoke coming out of the chimney. What comes out of the boiler? You do not know; well, when the kettle boils what comes out of the spout? Steam. Well, that is what comes out of the boiler, and it is the steam that makes the engine pull the train along. What can you see in the tender? The coals. For what are they used? To make the large fire boil the water. What do we call these large fires? Furnaces. How many men are there on the engine? Two. What would you say of them? They look dirty. What makes them dirty? What work do they have to do? Yes, one of them is called the engine-driver, and the other one is called the fireman or stoker. What has he to do? He has to keep up the fire. What would happen if the fire were to go out? The water would stop boiling, then there would be no steam, and then the train would stop. You see therefore that the fireman has to be very careful to keep up a good fire. Then he has to help the engine-driver to clean and oil the engine. If you were often to see an engine you would see the man with his large oil-can oiling the different parts. You must learn more about the engine another time.

What did you tell me comes after the engine? The carriages. How are they joined to it? By thick chains.

Now look and tell me if all the carriages are alike. No. Some are very much nicer than others. What do we call those very nice ones? First class. How many other kinds are there? Generally two others. We say there are first, second, and third class carriages. Which do you ride in? Why do you not ride in the first class? Now, quite at the end of the train there is a carriage into which you are not allowed to go. Do you know the use of this? Yes, it is for the guard. Who is the guard? What does he have to do? He is in charge of the train. He has to see that all is right. Very often there are two guards to each train. Do they both go into the same carriage? No, one is at the end of the train and the other is in front next to the engine. Do you know what the guard's carriage is called? Yes, the brake. If you were in the brake with the guard you would see that he turns a wheel just before the train comes to the station. This wheel is joined by a chain to pieces of thick wood near the wheels of the carriages. These pieces of wood then stop the carriage-wheels from turning round and this helps to stop the train. You would also see large windows at the back and sometimes at the top of the brake. The guards look out of these windows to see if all is right.

We have been speaking about the train, and now I want you to tell me what we have to do if we want to go in the train. If you were going to the train to what place would you go? To the railway station. Yes; and when you get to the station what do you have to get? A ticket. Where do you get that? At the ticket-office. Yes, you go to the little window and look through. You see a man inside, and he gives you the ticket. What do you give the man? Some money. Why do we have to give him money? To pay for our ride. Why does he give you the ticket? To show that we have paid for the ride. If you look into the office you will see a large number of shelves and piles of tickets. Did you notice what the man did to the ticket before he gave it to you? Yes, he put it in a machine. This little machine prints the date of the month upon it. Mary says the man cut the ticket with the scissors. Why did the man do that? Because she is a child. Yes; children only have to pay half as much as men and women, and so they have half-tickets. What have we to do next? Go on to the platform. Yes, but before you go on to the platform we have to show our tickets to a man. What does he do to them? Why? To show that he has seen them. What did he use to clip the tickets? A pair of pincers. They are something like pincers. What do we do next? Does the train come on the platform? Where then? By the side. On which part of the platform ought we to stand? On the part farthest away from the train. Why? What do you see on the platform? There are some seats. Why are they here? For people to sit down while they are waiting for the train. What else do you see? Sometimes there is a bookstall. Why do they have bookstalls on the platforms? For the people to buy books and papers to read in the train. Sometimes there is a refreshment room. What is the use of this? Can you tell me anything else you see on the platform? Well, what do you call these men? They are called porters. What have they to do? They open and shut the carriage doors, and answer any questions that they are asked about the trains; they carry the luggage, and they have to keep the station clean. How can you tell the porters? By the clothes they wear. Do the porters always stop on the platform? No; sometimes you cannot see one. Where are they? They go into a room on the platform. May you go there? No. Are there any rooms that you may go in? Yes. What are they called? Waiting-rooms. When must the porters be on the platform? When the train comes in. What do you do then? Wait until the train has quite stopped, and then get into the carriage. What happens then? The porter shuts the door. When does the train start? Yes, you hear a whistle. Who blows it? The guard. The engine-driver, when he hears it, lets off the steam whistle, and turns on the steam, and off goes the train. Where does it stop? At the next station. When it gets to your station what do you do? Sit still until the train stops, and then we get out on to the platform. What do you do before you leave the station? Give the ticket to one of the porters who is called the ticket-collector.

Note I.—The station-master has not been mentioned. The teacher might tell the children that at every station there is a head man, called the station-master, who has to see that the porters do their work, that the trains start at the right time, etc.

Note II.—The signalman and his work would almost form the subject of a separate lesson.

(To be continued.)

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Physiology.

BY ARTHUR NEWSHOLME, M.D. LOND.,

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CHAPTER IX.—DIET.

THE four chief elements entering into the composition of the body are carbon, hydrogen, oxygen, and nitrogen. In addition to these there is present a smaller amount of sulphur and phosphorus, and of certain salts. These elements are constantly being oxidised in the system, and subsequently eliminated from it. To compensate for this continuous loss, a corresponding replacement is required. If the elements could be taken *as such*, the question of diet would be very simple. Nitrogen and oxygen are present in abundance in the air and charcoal is easily obtained, while water consists of hydrogen and oxygen combined. But animals possess no power of elaborating from elements or inorganic compounds, the more complex organic bodies of which their tissues consist. The only element which is taken as such is oxygen, and this through the lungs, and not the alimentary canal. With the exception of salt, all other foods require to be *organic* in character. In this respect animals differ remarkably from plants, which elaborate complex organic substances from carbonic acid, ammonia, and inorganic salts; animals requiring vegetable food, or food derived by other animals from vegetables.

The five chief classes of food are—

(1) Nitrogenous Foods.
(2) Hydrocarbons or Fats.
(3) Carbohydrates or Amyloids
(4) Salts.
(5) Water.

These have been commonly divided into *tissue-producers* and *heat-producers*, the first class replacing the waste tissues of the body, and the second supplying combustible material, the oxidation of which maintains the heat and other forces of the system. The two classes are, however, not mutually exclusive. All tissue foods by their oxidation produce heat, while fats and carbohydrates doubtless help in the building up of new tissues, as well as in the direct production of force.

There are certain foods which do not directly serve as tissue or heat producers, but which are essential for promoting the assimilation of other foods. Thus water although already oxidised, and therefore incapable of generating force, is absolutely essential to the digestion and assimilation of food, to the interchange between the blood and various tissues, and to the elimination of effete matters.

Nitrogenous Foods include albumin, casein, gluten,

legumen, fibrin, and gelatin. They all contain the four elements—carbon, hydrogen, oxygen, and nitrogen, with a smaller quantity of sulphur, and in some cases phosphorus. There are two groups of nitrogenous foods; the first containing gelatin and chondrin, and the second containing bodies which receive the common name of proteids or albuminoids.

The nitrogenous tissues of the body are repaired by nitrogenous food. The molecular changes constantly occurring in these tissues lead to a certain amount of oxidation; but a much larger proportion of nitrogenous food becomes oxidised, without first entering into the composition of the tissues. Such breaking down of nitrogenous food especially occurs in pancreatic digestion and in the liver. The ultimate product is urea, with a smaller amount of uric acid; another part of the nitrogenous material being either stored up as fat, or oxidised into carbonic acid and water.

Hydrocarbons, or Fats, consist of three elements—carbon, hydrogen, and oxygen, the amount of oxygen present not being sufficient to oxidise completely either the hydrogen or carbon. Thus stearin, which may be taken as a typical fat, has the formula $C_3H_5(C_{18}H_{35}O_2)_3$. The deficiency of oxygen in fats is a dietetic advantage, representing potential force. In this respect they compare favourably with starch ($C_6H_{10}O_5$), and sugar ($C_6H_{12}O_6$). In starch $H_{10}O_5$ evidently $= 5H_2O$, and in sugar $H_{12}O_6 = 6H_2O$, so that in both cases only carbon remains uncombined with oxygen. It is found that dried fats produce by their oxidation 2½ times as much heat as a corresponding amount of sugar or starch. It is probable that the fat of food does not directly become the fat of the tissues, but that the incomplete oxidation of nitrogenous foods is its chief source. In the formation of milk, the production of fat globules from the protoplasm of the cells of the mammary gland can be directly traced. In the 'ripening' of a cheese, proteid material becomes similarly converted into fatty material.

Amyloids are inferior to fats in nutritive value, though more digestible. Starch becomes converted into grape sugar during digestion, and the two are practically equal in nutritive power. It is possible that under certain conditions amyloids may be a source of fat, though they, doubtless, chiefly act as an easily combustible material, saving the reserve fat in the tissues. Even when amyloids are entirely absent from the food, they may be produced in the system by the breaking down of nitrogenous matter. In the disease, diabetes, for instance, nitrogenous food becomes rapidly changed into grape sugar (glucose) and urea.

Salts, especially chloride of sodium, are essential for health. Half the weight of the ash of blood consists of sodium chloride. Potassium salts form an important part of milk, muscle, and blood corpuscles; they are obtained from bread, fresh vegetables, fruits, etc. Calcium phosphate, the best source of which is milk, is essential for the formation of bone.

Iron is an important metallic constituent of the body, as shown by the rapid removal of anæmia (bloodlessness) by its medicinal administration. It is chiefly contained in the hæmoglobin of red blood corpuscles, and is derived from flesh and milk. Veal and fish are usually deficient in it.

Water is an important article of diet. It is not simply taken as such, but forms a large proportion of the solid food taken. Thus 87½ per cent. of milk, 78 per cent. of fish, 72 per cent. of lean meat, 38 per cent. of bread, and 92 per cent. of cabbage consist of water. The water eliminated from the body by the lungs, kidneys, and skin represents the oxidised hydrogen of organic foods, as well as the water taken as such.

In constructing a dietary, the consideration of milk and eggs will afford important information, as these form the sole food of mammals and birds respectively in the first period of their lives.

The following is the composition of 100 parts of—

	HUMAN MILK.	COWS' MILK.
Casein	3·92	4·83
Albumin	—	·58
Fat	2·66	4·30
Sugar	4·36	4·03
Salts	·14	·55
Total solids	11·08	14·29
Water	88·92	85·71

It will be seen from the above table that nitrogenous foods are represented by casein and albumin, hydrocarbons by fat, carbohydrates by sugar, while salts and water are also present.

This diet amply suffices for an infant during the first ten months of its life, and the most healthy children are those whose diet has been thus restricted. During this period growth and development occur more rapidly than at any other time; the proportion of nitrogenous material is consequently somewhat higher than is required by an adult.

A *hen's egg* consists of 70 per cent. of water, and 30 per cent. of solid matter. The white of the egg is chiefly albumin. The yolk consists of a very digestible oil, rich in phosphorus, each particle of oil being enveloped by albuminoid material called vitellin. The absence of sugar is compensated for during incubation by the heat derived from the mother hen. The necessary salts required for growth are obtained by a gradual solution of the shell.

Eggs do not form so typical a diet for men as milk, owing to the smaller amount of water, the absence of sugar and of salts, and the excessive proportion of nitrogenous material.

The amount of food required by an adult may be ascertained by two methods. The dietary of an individual, who by its means maintains a healthy condition, may be analysed, and the number of grains of each of its elementary constituents ascertained; or the excretions, representing the completely oxidised condition of the food, may be estimated, and then the percentage composition of various foods being known, a compensatory amount may be allowed. Thus, if the amount of urea and uric acid eliminated by the kidneys, and of carbonic acid by the lungs be known, the number of grains of carbon and nitrogen required in the food is consequently known. A liberal margin must be allowed, owing to the fact that a certain amount of undigested food is contained in the fæces.

Adopting the plan of calculating the daily losses of carbon and nitrogen (these being the two chief constituents of food), Dr. E. Smith finds that an average adult loses daily during a period of idleness 4100 grains of carbon and 190 grains of nitrogen; while Dr.

Letheby finds, as the result of examination of dietaries, that an average adult loses during idleness 180 grains of nitrogen and 3816 grains of carbon; during routine work, about 300 grains of nitrogen and 5000 of carbon.

One may regard the amount of nitrogen required as averaging 300 grains, and of carbon 4800 grains. It is found in accordance with this that an average adult doing moderate work requires 4½ ozs. of nitrogenous food, 4 of fats, 14¼ of carbohydrates, 1 of salt; making a total of 22¾ ozs. (Moleschott). This is equivalent to a little over 40 ozs. of moist solid food. If we add 40 to 60 ozs. of water, we have a complete diet. Reckoned as grains, the proportion of nitrogen to carbon is as 1 to 16; while the proportion of nitrogenous food to carbonaceous (fatty and amyloid) is 1 to 4 or 6. The apparent discrepancy is owing to the fact that nitrogenous food contains a large proportion of carbon in addition to its nitrogen, etc.

Given the number of grains of carbon and nitrogen required by each individual, and a table showing the number of grains of these elements in a given weight of any article of food, a dietary can at once be constructed. The inadvisability of limiting one's diet to a single article of diet will at once be seen, as no one food contains the elements required in the proper proportion. In order to obtain sufficient nourishment from any one food, an excess of either nitrogen or carbon must be taken. If an excess of nitrogen is taken (as in meat food), the nitrogenous material tends to accumulate in the system in an incompletely oxidised condition, producing gout; if an excess of carbon, its incomplete oxidisation leads to corpulence.

Thus if one subsisted on beef alone, 2⅔ lbs. would be required to furnish enough carbon, and there would be a considerable surplus of nitrogen. If one subsisted on bread alone, to obtain 300 grains of nitrogen, 3⅓ lbs. would be required, and this would give a large excess of carbon. If one lived on eggs alone, which average 1¾ ozs. in weight, and yield nearly 18 grains of nitrogen, in order to obtain 300 grains of nitrogen, over 16 eggs would have to be eaten. The economy and advisability of a mixed diet will be obvious from these instances.

(*To be continued.*)

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Recent Inspection Questions.

[*The Editor respectfully solicits contributions—all of which will be regarded as* STRICTLY PRIVATE—*to this column. For obvious reasons, it cannot be stated in which district the questions have been set.*]

Arithmetic.

STANDARD I.

(1) 642+357+18+493+716. Ans. 2226.
(2) 304 − 296. Ans. 8.
(3) 387 − 195. Ans. 192.

STANDARD II.

(1) 28,619×47. Ans. 1,345,093.
(2) 30,012 − 19,008. Ans. 11,004.
(3) 44,207 ÷ 5. Ans. 8841+2.

STANDARD III.

(1) £2876 19s. 6d. + £978 0s. 8½d. + £2870 18s. 2¾d. + £0 18s. 11¾d. + £0 19s. 11¾d. + £674 19s. 10½d. Ans. £7402 17s. 3¼d.
(2) £100 − £90 19s. 2d. Ans. £9 0s. 10d.
(3) 701,506÷98. Ans. 7,158+22.

(4) 13 guineas + 9 half-crowns + 54 shillings + 27 pence + 25 sixpences. Ans. £18 4s. 3d.

STANDARD IV.

Two Cards Used.—First.

(1) Value of 49 horses at £47 15s. 11½d. Ans. £2342 1s. 11½d.
(2) Number of inches in a wire 4 m. 156 yds. long. Ans. 259,056 inches.
(3) £8496 17s. 11d. ÷ 89. Ans. £95 9s. 4¾d. + 81.
(4) If I have £510 to ÷ among some men and 6 boys, and give each boy 10s. 6d., how much is left for the men? Ans. £506 17s.

Second.

(1) Reckoning a man's steps 2 ft. 10 in., how long will a regiment of soldiers, each taking 75 steps per minute, go in an hour? Ans. 2 mls. 730 yds.
(2) £47,976 12s. 0½d. ÷ 94. Ans. £510 7s. 9¼d. + 76.
(3) £864 16s. 5¼d. × 198. Ans. £171,234 14s. 7½d.
(4) Write out square measure.
(5) 417,603 lbs. to tons. Ans. 186 tons 8 cwts. 2 qrs. 11 lbs.

STANDARD V.

Two Cards Used.—First.

(1) If 88 lbs. of tea cost £23 10s., what can I buy for £17 15s.? Ans. 66 lbs. 7 oz. $7\frac{3}{11}$ drs.
(2) Bill:— 8 pairs at 3s. 6d. per pr.
8 reels at 2 for 1½d.
24½ lbs. at 1s. 9d. per lb.
5¼ lbs. at 7s. 6d. per lb.
1½ gross at 2s. 9d. per doz.
Ans. £8 4s.
(3) A man bought 1916 yds. for 15s. 7¼d. per yd. and sold it at 17s. 6d. per yd., what was his gain? Ans. £181 12s. 5d.
(4) 5 cwt. 3 qrs. 14 lbs. at £10 15s. per lb. Ans. £7073 10s.

Second.

(1) 9 ac. 3 rd. 26 po. at £22 10s. per acre. Ans. £223 0s. 7½d.
(2) How many yds. would cost £68 17s. 6d. if 25 yds. cost £9 8s. 7½d.? Ans. 182 yds. 2 qr. $1\frac{211}{1000}$ nl.
(3) Bill:—
30 yds. at 7s. 6d. per doz. yds.
2 articles at 16s. 6d. each.
2½ doz. pairs at 3s. 6d. per pr.
6¾ yds. at 12s. per doz. yds.
21½ yds. at 4s. 2d. per yd.
£12 13s. 1d.

STANDARD VI.

(1) Int. on £438 from June 1st to September 13th, at 3½ per cent. per annum. Ans. £4 7s. 4¼d. $\frac{7}{25}$q.
(2) Simplify $\frac{30{\cdot}12}{{\cdot}0006} \times {\cdot}005$. Ans. 26.
(3) Simplify $\frac{\frac{7}{11} \times 3\frac{1}{2}}{\frac{1}{5} - \frac{3}{7}} \div 6\frac{1}{5}\frac{3}{5}$. Ans. $\frac{3}{56}\frac{5}{4}$.
(4) If 6 men reap 4·5 acres in 3·75 days, in how many days will 9 men reap 22·5 acres? Ans. 12½ days.
(5) A garrison of 5000 soldiers has provisions for 3 months, how many must be sent away, so as to last 8 months? Ans. 3125 men.

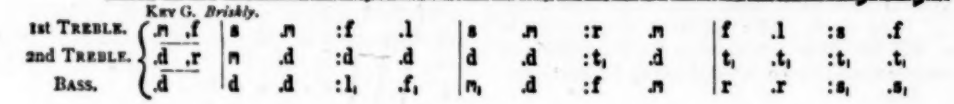
THE LITTLE PEDLARS.

Words by MELLICENT MOOR. *Music by* T. CRAMPTON.

Briskly.

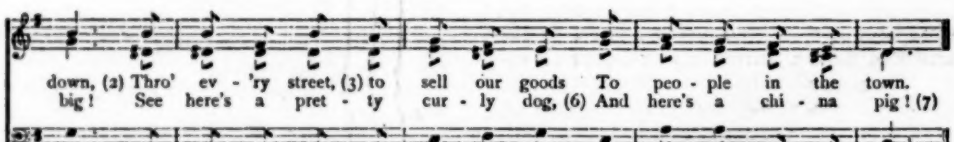
1st TREBLE. 2nd TREBLE. BASS.

1. Oh! we are lit - tle ped - lars, (1) And we're go - ing up and
2. Now won't you buy an el - e - phant? (5) 'Tis not so ve - ry

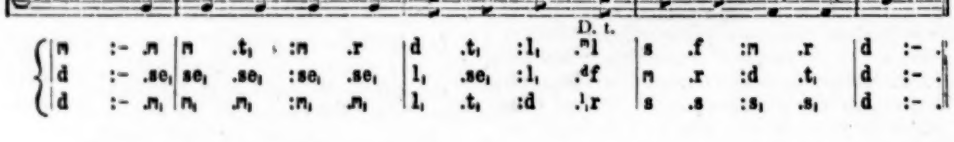


KEY G. *Briskly.*

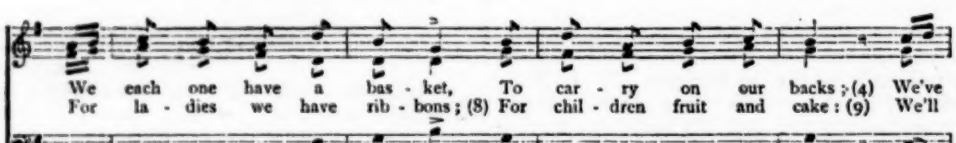
1st TREBLE. 2nd TREBLE. BASS.



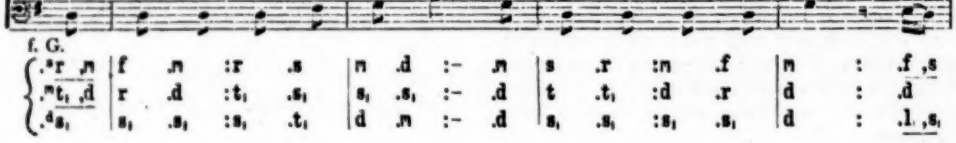
down, (2) Thro' ev - 'ry street, (3) to sell our goods To peo - ple in the town.
big! See here's a pret - ty cur - ly dog, (6) And here's a chi - na pig! (7)



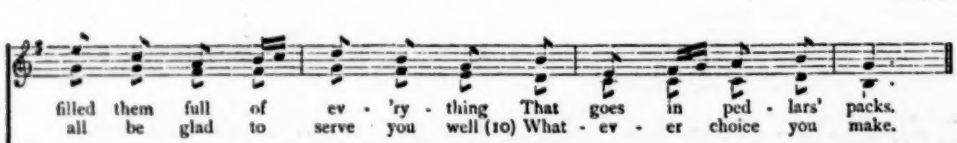
D. t.



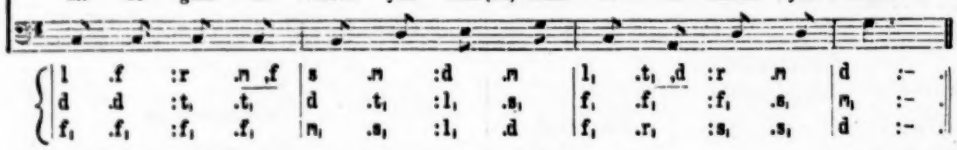
We each one have a bas - ket, To car - ry on our backs; (4) We've
For la - dies we have rib - bons; (8) For chil - dren fruit and cake: (9) We'll



f. G.



filled them full of ev - 'ry - thing That goes in ped - lars' packs.
all be glad to serve you well (10) What - ev - er choice you make.



(1) Make a bow. (2) Point to the left. (3) Point to the right. (4) Point with right arm over the left shoulder. (5) Hold up a slate. (6) Point to scholars in another class. (7) Point to another scholar. (8) Spread out both hands, as if showing a ribbon. (9) Extend both hands forward. (10) Bend head and hands, as in a polite bow.

THE FARMER'S CALL.

Moderato. *mf* *Music by* T. CRAMPTON.

1st TREBLE.
2nd TREBLE.
BASS.

1. Up the steeps the morn is bound - ing, Hark! the milk-maid's song is sound - ing!
2. Now, while earth and sky are glow - ing, Speed the plough-ing, speed the mow - ing—
3. Now, the west-ern sun des - cend - ing, Sha - dows with the light are blend - ing,

KEY C. *Moderato. mf*

1st TREBLE.
2nd TREBLE.
BASS.

Voice of bird and bee re - sound - ing— Up, my lads, be blithe as they! Chee - ri - ly,
Gay the song that cheers our go - ing, Glad - ly work we while we may! Chee - ri - ly,
And the herds are home-ward wend - ing— Cease the toil, but not the lay! Chee - ri - ly,

G. t.

CHORUS.

chee - ri - ly a - way, a - way!
chee - ri - ly we work a - way!
chee - ri - ly we sing a - way!

Chee - ri - ly we heed the call! A -

f. C. CHORUS.

Chee - ri - ly a -

f

- way we hast - en, one and all! A - way we hast - en, one and all!

- way, a - way!

f

Matriculation Hints.

By HENRY A. REATCHLOUS, M.A. (LOND.), B.Sc.,

Westminster Training College.

THE passages of Greek and Latin set from books not previously mentioned at the examination just concluded are given in another part of this number of the PRACTICAL TEACHER. A translation of them will appear next month.

French.—All who read these notes have no doubt made some progress in French. We need not therefore give directions to beginners. It may fairly be said that French is at the same time both easy and difficult. It is a language of which most people know a little, and few very much. Anything like sound instruction in French is very hard to get anywhere. In most cases the pupil must become tutor and use his French-master to give him the pronunciation of the words and the correct rendering of the sentences. The matter of pronunciation may seem of no importance with a view to a written examination. This is not so. It very much assists the memory to repeat aloud as well as read and write the grammatical forms and the examples to the rules of syntax; and without some knowledge of the sounds the student will rarely read aloud. A knowledge of French is becoming of more and more importance, both for pleasure and profit. In most cases it will not be taken up specially with a view to pass the examination. The student will not begrudge the time he spends upon it, nor be always on the look-out lest he should do too much. And let it be added his chances of success will be very much increased thereby; for it is not easy to say exactly how little will just secure a pass, and we would recommend nobody to try to find out for himself.

The student who tries to exercise his own judgment as to the books he will use and the methods he will adopt is sure to be struck and possibly confused by the disagreement of his guides. And this confusion will be all the greater if he fails to recognise that they are not all aiming at the same result. With some the ability to understand a few simple sentences and to reply to them is considered to be of more importance than being able to translate correctly a page of Molière. At that rate an English child of eight may be said to know English better than the foreigner who is able to understand the masterpieces of our language, but not able to converse fluently in it. And there can be no doubt that if conversational fluency is all that is required, our ordinary methods might be revolutionised with advantage. In order to acquire rapidly, and know perfectly the comparatively few things that would be necessary, we might be content to remain in ignorance of the thousand useless details that now fill the grammars and dismay the pupils. But with many the power to read and write French is of more importance than the ability to converse in it, and our methods must vary accordingly. While the requirements of examiners should not be too carefully studied, they should not be entirely disregarded. Most of us in this much-examined nation are at the present time, to some extent at least, *servi servorum*, the slaves of examiners who are not free themselves.

The examination in French consists of three passages of French, two of which have to be translated into English. There are also grammatical questions mostly restricted to the accidence upon the passages. There is no one book that can be recommended as much better than many others. When some such work as Smith's 'French Principia,' Pt. I., or Fasnacht's 'Progressive Course,' Pts. I. and II., has been mastered, reading should be pursued with vigour. Smith's 'Principia,' Pt. II., has an excellent vocabulary clearly printed. The extracts are followed by useful questions, which should be studied. Private students would do well to procure the answers from the publishers. Another reading-book containing similar extracts, but without questions or vocabulary, is the 'Modern French Reader,' published by Trubner, 2s. 6d. If the student gets tired of short pieces, he may try the selection from About's works, published by Hachette, 2s. 'First Lessons in French,' by H. C. Bowen, 1s.; and Prendergast's French in the Mastery Series, 2s., are both useful, and without taking too much notice of the directions at the beginning, which are impracticable for nine persons out of ten, students would learn from these two books what they will most likely not get elsewhere.

A few good grammars deserve notice: we call attention to Eve and Baudiss's, Fasnacht's 'Synthetic Grammar,' and Brachet's 'Historical Grammar.' Contanseau's Dictionary is clearly printed and quite full enough for ordinary purposes, so is Cassell's: Spier's, in two volumes, Littré's 'Abridgment,' and the 'Pocket Dictionary,' by John Bellows, are books which should be remembered and examined when opportunity serves. The student can then judge which will suit him best.

Natural Philosophy. — The student is recommended to get a balance and a set of weights; most likely he can have access to them without buying; no large school should now be without them. Good work can be done with inexpensive apparatus. The main point in a balance is its sensibility, *i.e.*, its readiness to turn upon the addition of a very small weight. To secure this there should be little friction, and the beams should be as long and light as is consistent with their remaining rigid when carrying the heaviest weights they are intended for. The arms should be of exactly the same length. We can see at once if they are so by putting two equal weights into the two pans. If one arm is longer than the other, the pan which is attached to it would descend.

The student is no doubt aware that if the arms were of unequal length, he could still obtain the true weight of a body by weighing it first in one scale and then in the other, and taking for the true weight the square root of the product of the two apparent weights. A better method is to put the body to be weighed in one scale pan, and counterpoise it with white sand, then remove the body and put weights to counterpoise the sand. These give the weight of the body.

This is called *Double Weighing*, and is a very accurate method.

Let now a considerable number of objects be weighed for practice, such as coins, pieces of metal, glass, and stone. Weigh a bottle when empty, and again when full; the difference will give the weight of the liquid in grammes, and then, such is the simplicity of the metric system, we can state at once the capacity of the bottle, because a cubic centimetre

of water weighs a gramme. Now attach a fine wire to one arm of the balance, and fix on the other end of it a piece of metal. Weigh the metal in air first, afterwards weigh it when it hangs in the water; notice the loss of weight. This loss of weight in grammes gives us the volume of the body weighed in cubic centimetres. Conversely take a body that can be easily measured, and find its volume in cubic centimetres, then weigh it successively in air and water; it will be found to lose as many grammes in weight as it occupies cubic centimetres in volume. This is a verification of the law of Archimedes, that bodies immersed in water lose a part of their weight which is exactly equivalent to the weight of the volume of water they displace. If we know the weight of a body when weighed in water, and also the volume of the fluid which it displaced, we can calculate its weight in air by adding on the weight of the water displaced. We shall return to this subject when dealing with specific gravity. Meantime, it would be well to notice the effect on the weight of the body immersed if a considerable amount of salt be put into the water; and if the balance is sufficiently sensitive, the effect of substituting very hot for very cold water. Water is densest at 4°C., and if we call its density unity at 4°C., at 10° it is ·99974; at 15°, ·99915; and at 20°, ·99827.

It will, no doubt, have occurred that if a body weighed in water loses a part of its weight, equal to the weight of the fluid displaced, bodies weighed in air do the same, and it is so. And when we remember that a litre of air at standard temperature and pressure weighs 1·3 gm., which is the same as saying that a cubic foot weighs 1·3 oz., it will be seen that it is too much to be neglected where the greatest accuracy is required. As the weight of a litre of air will depend on the temperature and pressure, and also upon the amount of moisture in the air, it is necessary to read the thermometer and barometer, and find the dew-point in the room when such delicate experiments are made. For example, suppose a body weighs 50 gms. in air, we must find the volume of the body, and then the weight of the same volume of the air in which the body was weighed: let this be ·05 gm. Again, suppose the volume of the air displaced by the weights used weighs ·01 gm., then the true weight of the body in vacuo would be 50+·05−·01=50·04 gm. Corrections for the weight of air displaced are often unnecessary, but questions are occasionally set which imply a knowledge of them.

In studying the laws of falling bodies, an Attwood's machine is most helpful. The only essential part is a grooved wheel, turning with as little friction as possible. This is usually accomplished by letting the axle lie on the circumference of the other wheels. A watchmaker will generally supply the wheels, and help to fit them up. We advise the student to make a machine for himself. He will be amply rewarded for his labour.

(*To be continued.*)

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UNIVERSITY OF ST. ANDREWS. L.L.A. EXAMINATIONS, 1884.—The results of the above examination have just been issued, from which it appears that 363 candidates entered for examination in twenty different subjects, and that of these eighty-one passed in the requisite number of subjects to enable them to obtain the title of L.L.A.

ANSWERS TO ALGEBRA QUESTIONS IN 'THE SCHOLAR,' FOR JULY, 1884.

EXERCISE XXXI.

(1) a^4x^5 (2) a^9b^{12}
(3) x^4y^{12} (4) $-a^9b^3$
(5) $\frac{a^5}{x^3y^3}$ (6) $\frac{a^8m^3}{b^3n^5}$
(7) $\frac{9a^2b^2}{16}$ (8) $\frac{1296a^4b^8}{c^4d^4}$
(9) $-\frac{x^6y^3}{27a^3b^3}$ (10) $-\frac{32a^5b^5c^{10}}{3125x^{15}y^5}$
(11) $x^2+xy+\frac{1}{4}y^2$ (12) $a^2-\frac{2}{5}ab+\frac{1}{25}b^2$
(13) $\frac{1}{9}a^2-\frac{1}{3}ax+\frac{1}{4}x^2$ (14) $x^2+\frac{2}{3}xy+\frac{1}{16}y^2$

EXERCISE XXXII.

(1) x^2; $5xy^3z^2$; $12a^2b^3$
(2) $\frac{2}{3}x^3y^5$; $\frac{1}{4}axy^2$; $\frac{2}{3}a^2bc$
(3) $81x^2y^3$; $\frac{11}{12}a^2b^2$; $\frac{1}{3}x^{12}y^3$
(4) ab; xy^2z; $\frac{x^2y^3}{z}$
(5) $2xy^2z^3$, $9ab^2c^3$, $\frac{3}{4}mn^2$
(6) $6ax^2$ (7) $7xyz$

ANSWERS TO ARITHMETICAL QUESTIONS IN 'THE SCHOLAR' FOR JULY, 1884.

STANDARD III.

A. 1. 2103+2.
2. 2565+5.
3. 1562+6.

B. 1. 24,658.
2. 6993+43.
3. 2456+52.

C. 1. 6818+159.
2. 85,513+74.
3. 82,004+19.

D. 1. £17 5s. 0d.
2. £322 2s. 6d.
3. £12872 11s. 10½d.

E. 1. £290 8s. 3¾d.
2. £88,826 14s. 4½d.
3. £66 4s. 4½d.

STANDARD IV.

A. 1. £29 6s. 4½d. +77.
2. 2739 lbs. 1 oz. 3 drs.
3. 2250.

B. 1. £26,879 4s. 5¾d.
2. 1,473,120.
3. £12 12s.

C. 1. £10 16s. 2½d. +14.
2. 803 fur. 28 po. 4 yd. 2 ft.
3. 606,528.

D. 1. £14,440,650.
2. 27,878,400 sq. ft.
3. 10,454,400 sec.

E. 1. £2 19s. 7½d. +11
2. 120 lbs.
3. £1861 10s.

F. 1. 12s. 0½d.
2. 4s. 6½d.
3. 23 times.

STANDARD V.

A. 1. £233 16s. 10½d.
2. £2205 3s. 8d.
3. £3429 3s. 4½d.

B. 1. $3\frac{17}{18}$.
2. $4\frac{5}{16}$ oz.
3. £764,360 8s. 9d.

C. 1. (3s. 7½d.; £1 6s. 3d.; £8 12s. 6d.; 12s.); total, £10 14s. 4½d.
2. £1540.
3. $\frac{8}{9}\frac{8}{9}$.

D. 1. 64 hours.
2. (1s. 5½d.; 1s. 6d.; 7s. 10½d.; £11 18s. 8½d.) = £12 9s. 6½d.
3. £1162 11s. $11\frac{7}{10}$d.

E. 1. 84 lbs.
2. £490 10s. 10d.
3. $\frac{33}{175}$.

F. 1. £170 6s. 4½d.
2. (3s. 4d.; 4s. 4½d.; 9s. 4d.) = 17s. 0½d.
3. £23 12s. 6d.

STANDARD VI.

A. 1. 22; 414,480.
2. $\frac{1}{2}\frac{1}{4}\frac{1}{8}$.
3. £2069 14s. 6d.

B. 1. ·0003252.
2. £153 6s. 4½d.
3. 17·3; ·0173.

C. 1. 15s. 9d.
2. 33 ft.
3. £1 2s. $8\frac{48}{100}$d.

D. 1. £732.
2. 2·1714285.
3. £1000.

E. 1. 3185 halfpence.
2. ·0001092.
3. £11 3s. 1½d.

STANDARD VII.

A. 1. 4·675.
2. 12½ p.c.
3. £103 14s. 6¾d.

B. 1. 1 oz. 4½ drs.
2. 5¼d.
3. £2600.

C. 1. 33⅓ p.c. increase; 12½ loss; 20 p.c. increase.
2. £3 1s. 5d.
3. £989 1s. $8\frac{8}{11}$d.

D. 1. £$\frac{1}{8}$ or 5s. $9\frac{3}{11}$d.
2. $9\frac{3}{11}$.
3. £494 1s. $8\frac{3}{11}$d.

ANSWERS TO ARITHMETICAL QUESTIONS IN 'THE LITTLE LEARNER' FOR JULY, 1884.

STANDARD I.

(1) 2660
(2) 802
(3) 171
(4) 2618
(5) 292
(6) 195
(7) 678
(8) 90
(9) 583
(10) 1849
(11) 2698
(12) 4698
(13) 3794
(14) 144
(15) 92
(16) 3517
(17) 11
(18) 8
(19) 1704
(20) 481
(21) 698
(22) 3511
(23) 221
(24) 98
(25) 3810
(26) 95
(27) 457

STANDARD II.

A. (1) 351,166
(2) 243,579
(3) 187,276
B. (1) 9374
(2) 9266
(3) 13,034
C. (1) 691,355
(2) 778,437
(3) 393,778
D. (1) 1,210,006
(2) 3,340,302
(3) 5,704,314
E. (1) 71,075,400
(2) 59,770,200
(3) 95,596,160
F. (1) 2921+4
(2) 11,418+1
(3) 10022+6
G. (1) 1992+1
(2) 2918+1
(3) 2568+6
H. (1) 1330+35
(2) 663,674,000
(3) 34,323,870

The Discipline of the Mind.

BY W. C. COUPLAND, M.A., B.SC.,

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III.—ASSOCIATION AND MEMORY.

IT is characteristic of Mr. Herbert Spencer's treatment of Mind that he has striven to show how much may be learnt from even a hypothetical account of the Genesis of Nervous Systems, and what an increase of insight we obtain into mental laws when we unravel their physical conditions. Much has been written and surmised about the connection of ideas, but the larger part of such discussions has consisted rather of description than of explanation, and the real grounds of these connections have escaped notice through the fatal limitation of inquiry to the reports of inward self-examination. For although we freely own that in the last resort consciousness is the source of all our knowledge, the slow progress of mental science is a sufficient demonstration of the assertion, that to neglect the study of the organic conditions of Mind is to miss the clue to the understanding of some of the most familiar phenomena.

These remarks are peculiarly pertinent here, for on the one hand the trivialities which have passed for mental science, and on the other, the embarrassments experienced by psychologists alive to certain prevailing fallacies, but unable to replace them by sounder knowledge, might be largely illustrated from the treatment of Association and Memory. The usual instruction on the subject amounts to this, that it is erroneous to regard the mind as a 'store-house,' that impressions and ideas are not laid up as it were in a cupboard for further use, and that there are certain principles of association which, according to different authorities, variously range from one to a dozen.

With regard to the Laws of Association and Memory, attempts have indeed been made to justify the favoured number; but why there must be this number and no more, why there should be association at all, and wherefore the popular view is erroneous which regards memory as a kind of spiritual receptacle has been far from clearly seen. Now the truth of the matter is simply this, that the permanent element is not mind at all, but a more or less settled material fabric, a connected nervous system, the degree of whose elaboration rigidly determines the extent of the mental powers. In a rudimentary nervous system, the various parts of which are very loosely connected, a very low state of mind will alone be possible; but at a further stage, where nerve-bundles are consolidated and the inter-dependence of distinct centres is effected by very definite communications, not only will the retentive power be strengthened, but the recall of the past be correspondingly facilitated. Ideas *as* ideas have no permanent existence, they only survive the brief moment of conscious apprehension, but a very similar state of consciousness can be brought about if the old nervous tracks be struck upon, and if the various nervous connections are in good working order.

A glance at the anatomical relations renders at once intelligible the important part played by association in the mental life. It is almost impossible to stimulate the nervous system either centrally or peripherally without the influence being propagated in various directions, determined primarily by the structural connections, and secondarily by the intensity of the shock. Experience tells us that nothing is more difficult than to confine the thoughts to a limited area. To check the spontaneous flow of feelings, to forbid the natural conjunction of ideas, may often require considerable effort, and when we are dealing with impressions of sense may even be impossible. The art of education may indeed almost be summarized as the art of facilitating or hindering psychical associations, and the limits of that act are inexorably defined by the given structural conditions.

It is fortunate for us that the *fatal* element, as one may call it, is thus dominant, for were these nervous connections not so determinate the acquisition of the simplest ideas would be enormously difficult. We require the co-operation of sense-impressions and muscular movement every moment of our lives, but the rapidity of these all-important acquisitions is, in most cases, out of all proportion to the amount of deliberate effort. As we get further away from sense, however, the bond of association is more difficult to forge, and the most prolonged endeavours may prove fruitless. Each period of life has its favoured associations, rendered possible by the degree of nervous development. In early life, when the organs of sense are far more developed than the brain, the sense-cohesions will be far more numerous and stronger than intellectual combinations. Such inward life as there is will consist of repetitions in imagination of past sensations and external impressions. Later on, when the ruts of custom in the region of sense are well worn, the mind will be less distracted by the brilliant setting of its pictures, and will come to dwell more upon the grey nucleus of constant properties. These recurrent attributes will haunt the mind, and

objects will be linked together through the possession of common properties rather than by mere external affinities.

Memory is so largely a case of association that the 'Laws of Association' are usually presented as 'Laws of Memory.' There is little to be gained, indeed, by insisting on the greater generality of the laws of association. It is conceivable that impressions might be connected without any consciously apprehended interval between them. Thus it would be hard to say which arose first in the mind, in that indissoluble conjunction, the shape and colour of a body; but a non-serial consciousness, if there be such a thing, is a phenomenon, in the case of man at least, which must be exceedingly limited in its manifestation. It is quite true that we cannot remember our first years, that is, cannot recall events belonging to so early a period; but that the lack of the power of reproduction does not preclude memory, the recognition of a host of objects by infants sufficiently proves.

The capability of remembering implies two things, *retentiveness* and *recognition*, but the former of these terms must be carefully defined or it will be suggestive of error. Strictly speaking, the mind *retains* nothing. What happens, expressed in the language of psychology, is a succession of modes of consciousness recurring from time to time either in the same or in some other order; in physiological language, a number of nervous changes in large part indistinguishable in character from one another. What is past is beyond recall in its original form, what remains is a *disposition*, a lessened power of resistance to similar exciting influences. But this is not all. A repetition of like causes leads to an assimilation or identification of the effects. It is not enough that there be an echo, the echo must reinstate the past, in its truthful outline at least, so that we can say, 'I had a like experience to this on some former occasion. What to me now is idea once was feeling.' The laws of association, then, considered as laws of memory, tell us the way in which these results are obtained, or at least aim at this result, although, as I mentioned at the outset, no explanation is satisfactory which does not take full account of the physical conditions. This being understood, we may now proceed to consider memory exclusively on the subjective side.

A good memory implies speedy reproduction of ideas, a rapid recovery of pictures of scenes formerly witnessed, or a review of conceptions in the order and connection in which they were previously meditated by the mind. It is clear that for the securing of these results the mind must be very impressible in respect of the class of ideas recalled, and that the more numerous the relations of such ideas are the greater will be the likelihood of their being brought within the field of view. As regards the former of these requirements, it may be said that nothing can compensate for considerable obtuseness of faculty. A readiness to be affected by very slight influences is, after all, the supreme condition of memory. Within the same mind, however, there are noticeable the greatest differences in this respect. It is not easy to find a good memory for strongly contrasted orders of facts and truths, a circumstance which must doubtless find its ultimate explanation in the law of the conservation of energy. A good memory may be inferred where the attention is quickly arrested; for this means that the mind will spontaneously recur to the particular class of facts, the aliment offered evidently suiting the constitution.

It is almost saying the same thing in other words when we add that things are most easily remembered where the mind experiences pleasure in cognizing them; for where there is pleasure there is little or no resistance to be overcome, and all the energies are absorbed in the contemplation of the object of interest. Where there is deficient susceptibility we endeavour to make up by repeated impression for the lack of natural fascination. We try to conquer the stubborn intellect by dint of hard and frequent blows. Or the mind is bribed by insinuated pleasure to think on what is naturally indifferent to it. The policy of enforced repetition may be regarded as the discipline of pain, which thus appears in the matter of acquisition to be a hard necessity or secondary resource rather than a primary aid.

Next to the natural susceptibility to impressions the best hope of obtaining a good memory lies in a large store of ideas. The consequence is that the paths to any goal are multiplied, and the chances are increased of clues being found to any forgotten idea of which we are in search. The Principle of Association, usually styled the 'Law of Contiguity,' expresses this condition of memory. It is to the effect that all present states of consciousness tend to drag to the light portions of bygone experience with which their constituents have been connected, either through their having occurred in proximate periods of time or through some special relation of dependence or logical affinity. As in the former case, the firmest cohesions are those which are spontaneously formed, but we may do much to strengthen the contiguous bond by observing certain rules. In early life Nature's tuition is most effective. Sequence alone is then sufficient to form associations; and in most cases the rapidity of acquisition, as illustrated by learning by rote, is truly astounding to the adult mind bereft of such power. It is enough at that early stage that two things occur together, for an indissoluble connection to be forged, and to the very last we are called upon to bless or lament these fortuitous conjunctions. So readily indeed are the links fashioned, that they may elude all control, and there are few who have not cause to regret the tenacity of unbidden associations at some time of their lives. But it cannot be denied that the gain outweighs the disadvantages, and that it would be a mistake to try to discourage this spontaneously associating power. On the other side its direct encouragement requires very considerable judgment; and for that reason it may not be unjustifiably argued that the ablest and wisest teachers are needed for the training of the most youthful minds. The amount of mischief that is done by abusing the great Law of Contiguous Association is incalculable. Some day Society will visit with its sternest reprobation those who abuse their trust to create associations in child-minds which have neither reason nor good principle on their side. It must never be forgotten that it is easier to make than to break an association; and, though man has to a certain extent succeeded in assisting memory, he has not been very successful in framing aids to forgetfulness. But it should not be lost sight of that the latter are almost as much needed as the former. How to forget is often a very serious question; and there would seem no other recipe than this—form fresh associations which may neutralise the

effect of undesirable bonds, and then aid the struggle for existence by continuous concentration on the worthier alliances.

With advancing years more may be safely done in the way of assisting memory than in the earlier period of life. It is usually futile to rely upon the natural plasticity in the hope of producing adhesions by mere time-sequences. 'Learning by heart' is now mostly a waste of time, requiring an effort altogether out of proportion to the value of the result. Resort must now be had to the principles of logic for the cultivation of memory. Memory will be best served by clearness of arrangement, by observing a logical sequence in the course of study, and by relying more on distinctness of conception than on wealth of facts. The mind cannot be supplied with too many facts in the earlier periods; but with the decrease of plastic power, inevitable with increase of years, the materials of knowledge will stand a poor chance of being preserved, unless they are assimilated with previous knowledge and cast in the logical moulds. Hence the importance at this stage of system, of reduction to rule, of deliberate sorting of knowledge. In fact, the other law of Association, which has been called the 'Law of Similarity,' is here the paramount principle, and its importance increases the further the pupil advances on the scientific path. This law affirms that impressions and ideas are associated by resemblance; and the perception of resemblance lies at the root of all the higher qualities of intellect. There is no more powerful aid to memory than the effort to string a number of particular experiences on a common thread, to see that the same principle is illustrated by a host of particulars. Once let the general expression or *law* be comprehended, and the details can be trusted to take care of themselves. All who have been called upon to master a host of details, as in the study of Chemistry, for example, will bear witness how bewildering was the mass of observations and experimental results at first; and the task of remembering all the compositions and decompositions seemed hopeless until substances were arrayed in serial order, and natural alliances were made plain.

In speaking of the deliberate training of the memory, we cannot pass by a question which has been often mooted and answered in very different fashion: whether there be not artificial aids to memory which a thoughtful teacher might find serviceable. In a limited way resort has been had to artificial mnemonics in the shape of doggerel lines for the permanent preservation of some important piece of information which cling to the memory and save the effort of distinct recollection. Mnemonics are sometimes based upon the 'Law of Contiguity,' as in the case of the rhythmical flow of verse which, by the alternate rise and fall of the voice, suggest a continuity that would be lacking in plain prose. In other cases the 'Law of Similarity' is invoked, as in certain aids to the remembering of numbers, by framing a *memoria technica*, which represents numbers by letters, and embeds the latter in some phrase descriptive of the event whose date is to be re-called. Despite the utility of such mnemonics in certain peculiar cases, I apprehend that as a rule purely artificial auxiliaries are undesirable.

The case of numbers is a decided exception, but an exception which justifies the rule. Numbers, as perfect abstractions, can have no natural associations. All numerical changes being rung on ten digits, to expect the human mind to remember more than a very few events by endeavouring to strike up a cohesion between a concrete fact and the permutations of a highly ambiguous set of symbols, is utterly unreasonable. But when we have excepted numbers I do not know that there are any cases where a scientific treatment would justify the systematic employment of mnemonics. Mnemonics are not applied psychology, and applied psychology, one form of which is mental discipline, must be a lawful deduction from the laws of mind. Individuals may, if they please, avail themselves of *memoriæ technicæ*, but the use of such must always remain empirical, and what is a help to one may be a hindrance to another mind. The genuine training of the memory consists in detecting and employing the threads of association which the mind gathers in its spontaneous operation. These methods are necessary, and the art which leans upon them is, what it should be, 'nature better understood.' Exercise strengthens the contiguous bond—perception of cause and effect, and personal experimentation; and the logical laws of the intellect must be obeyed to gain command over groups of facts.

As mental progress of all kinds is dependent upon a good memory, it is evident that the Discipline of the Mind should before all things take care that this fundamental power be strengthened to the utmost, and carefully preserved from deterioration. Nothing is more injurious to real acquisition than to exact from the mind more than its stage of development will justify, or to endeavour to assimilate faster than the nutritive forces permit. It will not be difficult to discover what the right pace of acquisition for any mind really is, if the learner's natural interests be carefully studied. It may be regarded as certain that, where there is great eagerness for any study, a strong memory will be an unfailing accompaniment; our proclivities point out pretty plainly what sort of food we shall most readily assimilate. When the interest is weak and the thoughts easily wander, the cost of acquisition will be considerable, and the wise teacher will be very careful how he endeavours to hasten the pace. The effect may be that the mind is actually thrown back in its course; it is filled with make-believe knowledge, which is retained until it has answered its purpose, say of some 'examination,' and then the seemingly fair fabric of acquired truths vanishes utterly, leaving barrenness and a sense of weariness behind it. Again, when the mind has attained a fair amount of abstract power, nothing is more detrimental to solid acquisition than too extensive reading. How common it is to find men and women who have read everything, and yet know nothing, who have not a general idea within their grasp, their intellectual power having been frittered away in the mere accumulation of facts, or who cannot bring their disorderly knowledge to converge upon any desired point.

We *enfeeble* the memory by trusting too largely to contiguous association, and neglecting logical concatenation. Whoever would have a powerful memory must reflect quite as much as observe. Less stress should also be laid on repetition than on discernment of right relations. A subject is generally more fully mastered by once seeing it in its proper proportions than by any number of re-readings. Nor must we despise the aid of the emotions in the cultivation of memory. If an enthusiasm can be aroused for a subject, there is little doubt that the result will be permanent, but if

the intellect be flogged to its task, if the eye is straying wistfully after some other passionately-desired object, progress will be insignificant.

A pictorial imagination is a good aid to memory, but an ill-balanced constructive imagination is a doubtful ally. By a constructive imagination is meant an imagination that decomposes its experiences and reconstructs them to subserve some particular feeling. Now memory is worthless that is not *faithful*, hence a too exuberant fancy is antithetic to real acquisition. But an imagination which depicts objects to the mind as they really are is an invaluable aid, and may indeed become of supreme importance.

I do not intend hereby to undervalue the constructive imagination, but this is not the place to enlarge upon its part in the intellectual economy. Here the object is to show how the mind may become a mirror of reality, and how the images reflected on it may be saved from permanent destruction. Above all things, therefore, we have to guard against a *confused* memory, which is one of the most unmistakable marks of an ill-trained mind. How difficult it is to obtain a clear and precise narrative of observed events! The narrator not unfrequently intermingles figments of his own unbridled imagination, and mixes up with the fragments of direct perception patches of other days' experiences or ill-grounded inferences. For a just memory, then, we require an habitual self-restraint, a habit of close observation, and an accurate classing of experiences with their allied forerunners. We stumble here upon a truth, of which the student of mind is never long without reminder, viz., how arbitrary are our classifications of the mental powers and functions, for we see plainly that a discussion of memory implicates observation, the imagination, the process of reasoning, even the emotions and the will.

(To be continued.)

Chemistry of the Non-Metallics.

BY EDWARD AVELING, D.SC. LONDON.

[This series of articles, whilst dealing with the subjects required by the University of London for the Matriculation Examination and with those required at the Elementary Stage of the Inorganic Chemistry (Branch X.) Science and Art Department, is intended as a practical guide to the philosophical and systematic study of the non-metallics.]

BAROMETERS.

(1) *Construction and action.*—If a wide, clean glass tube, about 800 mm. long, is filled with mercury, and the

Fig. 7.

open end being temporarily closed by the finger, the tube is inverted, placed with the open end in mercury, and the finger removed, the column of mercury in the tube will descend, until at last it ceases to fall, and remains stationary. It will then be noticed that its height above the level of the mercury in the outside vessel is about 760 mm. Such a tube under such conditions is the simplest form of barometer (Fig. 7). The mercury in the tube is sustained by the pressure of the air. If the pressure of the air increase, the column of mercury will rise. If the pressure of the air, from any cause, diminish at the particular part of the earth where our barometer is situated, the column of mercury in the tube will fall to a greater or less extent. Hence the height of this mercury column is a measure of the pressure or weight of the air at any given time and place. Hence the name of the instrument, βαρος (baros) = weight, μετρον (metron) = measure.

BOYLE'S AND MARIOTTE'S LAW.

A gas placed in any enclosed space diffuses over the whole of such space, no matter how small may be the quantity of gas concerned. If the dimensions of such an enclosed and enclosing space were made to contract, pressure would now be exerted upon the gas, and the volume of the gas would be lessened. To ascertain the exact connection between the volume occupied by gases and the pressure exerted upon them was the object of Boyle and the object of Mariotte. These two observers, working independently, arrived at the same conclusion, that is, the law or verbal expression of an observed order of events is known sometimes as that of Boyle, sometimes as that of Mariotte. At present we are not considering the temperature of the gases studied; that temperature is for the present to be regarded as constant. A bent glass tube is taken with one limb shorter than the other (Fig. 8). The shorter limb is closed, and a

Fig. 8.

Fig. 9.

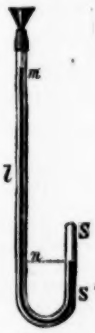

Fig. 10.

funnel is jointed on to the open end of the longer limb by a piece of india-rubber. At present the tube is full of air, and this air is the gas on which the experiment is to be tried. At present also the air that is in the bent tube is under the pressure of the atmosphere outside, as are all bodies at the surface of the earth. Let us assume that the barometer at the time stands at 760 mm., and the air-pressure is equivalent to that exerted by a column of mercury 760 mm. in height. Pour mercury in through the funnel until the bend of the tube is filled, and the air in the short leg is completely shut off from the air in the long leg (Fig. 9). That confined air is the especial portion of gas on which the experiment is to be made. It is still only under the air-pressure equivalent to 760 mm. of mercury, transmitted to it through the mercury in the bend. Its volume under that pressure is the volume of the short limb. Denote this by v.

Under pressure = 760 mm., the gas occupies volume = v. Pour in more mercury *viâ* the funnel. The mercury rises more rapidly in the long limb than in the short closed one, as in the latter its inflow is resisted by the imprisoned air. Continue to introduce mercury until the fluid in the short limb is exactly half way up the limb (Fig. 10). The

volume of the air is now exactly half what it was under pressure 760 mm., or is $\frac{v}{2}$. Let us see what pressure it is under. First, there is the old air pressure = 760 mm., still acting and transmitted through all the mass of inpoured mercury. Second, there is the pressure due to that inpoured mercury, but not due to *all* that has been introduced. For the mercury in the bend of the tube exerts no pressure upon the air in the upper part of *SS'*. Nor does the mercury in the lower part of *SS'* exert any pressure on the air above it. It cannot press upwards. It is, indeed, pressing downward with its full weight, and would fall were it not for the mercury in the longer limb. Just so much mercury in the long limb as there is of the fluid in the short limb has to support the mercury in *SS'*, and cannot, therefore, press upon the air in *SS'* at all. What, then, is left to exert weight-pressure upon the enclosed air? The column of mercury from *n* to *m* in the long limb, *i.e.*, from a line level with the level of the quicksilver in *SS'* up to the top of the liquid in *l*: a column of mercury, in brief, whose height = the difference of level of the fluid in the two limbs. Measuring this difference of level it is found to be 760 mm. Hence the gas, occupying one-half its former volume is found to be under the pressure of (1) the air = 760 mm. of mercury; (2) 760 mm. of mercury.

Under pressure = 760×2; the gas occupies volume = $\frac{v}{2}$.

If mercury is poured in until the volume of the air in *S* is reduced to $\frac{1}{3}$, the difference of level is found to be 1520 mm., or twice 760, and as the air-pressure is still acting and is still transmitted, under pressure = 760×3, the gas occupies volume = $\frac{v}{3}$. And, generally, it is established that under pressure of $760 \times n$ the gas occupies volume = $\frac{v}{n}$, *i.e.*, the volume of a gas at constant temperature varies inversely as the pressure upon it. And this is Boyle's and Mariotte's law.

EXAMPLES ON BOYLE'S LAW (*Solved.*)

(18) A Boyle's tube has a short limb, whose contents are 60 cc. What must be the difference of level of mercury in the two tubes that the air may only occupy 25 cc.? Barometer stands at 750 mm.

Given a Boyle's tube with short limb, whose contents = 60 cc., and the barometer standing at 750 mm.

It is required to find the difference of level of mercury in the two limbs if the air occupies 25 cc.

The air occupies 60 cc. under a pressure of 750 mm. mercury.

" " 1 " " 750×60

" " 25 " " $\frac{750 \times 60}{25} = 1800$;

∴ the difference of level = 1800 − 750 = **1050 mm.**

(19) A Boyle's tube has a short limb two decimetres in length. How much mercury must be poured into the tube that the level of that in the closed limb may be two centimetres from the top? Barometer at 768 mm.

Given a Boyle's tube whose short limb has a length of 20 cm., and the barometer standing at 768 mm.

It is required to find how much mercury must be poured in, that the air in the short limb may occupy 2 cm. length.

18 cm. in the short limb are filled with mercury; ∴ 18 cm. are required in the long limb to balance these, and total mercury *not* exerting pressure on air = 36 cm. = 360 mm.

The air occupies 20 cm. under a pressure of 768 mm. mercury.

" " 1 " " " 768×20

" " 2 " " " $\frac{768 \times 20}{2} = 7680$

Total mercury required = 7680 − 768 + 360 = **7272 mm.**

(20) Into a Boyle's tube, whose short limb = 3 centimetres in length and is 1 square millimetre in section, water is poured until the air only occupies 10 millimetres of the short limb. What weight of water has been introduced? Barometer at 760 millimetres.

Given a Boyle's tube, whose short limb = 30 mm., into which water is poured until the air only occupies 10 mm.

It is required to find what weight of water has been introduced.

20 + 20 mm. of water are required to balance each other = 40 mm.

Air occupies 30 mm. under pressure of 760 mm. mercury.

" " 1 " " " " 760×30

" " 10 " " " " $\frac{760 \times 30}{3} = 2280$.

But a pressure = 760 mm. mercury is due to the atmosphere, and is merely transmitted, ∴ 2280 − 760 = 1520 mm. is the amount of mercury required. The specific gravity of mercury = 13·5; ∴ $1520 \times 13{\cdot}5 = 20520$ mm. water are required.

Total amount = 40 + 20520 = 20560 cubic mm.

Now the *weight* of water is required.

1 cubic centimetre = 1 gram.,

20560 cubic mm. = $\frac{20560}{1000}$ cubic centimetres weighing **20·56 grams.**

(20*a*) Find the length of the short limb of a Boyle's tube, if, after altogether 243 cm. length of mercury have been poured in, the air in the short limb occupies $2\frac{1}{2}$ cm.

Let *x* represent the length of the mercury column in the short limb.

∴ $(x + 25)$ mm. represents the length of limb.

Under pressure 760 mm. vol. $= x + 25$

1 " " $= (x + 25) \times 760$

" " 760 " (due to air) + $(2430 - 2x)$, due to difference of level of mercury $= \frac{(x + 25) \times 760}{760 + 2430 - 2x}$

But vol. = 25 mm.

$\therefore \frac{760\,(x + 25)}{3190 - 2x} = 25$ ∴ $\frac{152\,(x + 25)}{3190 - 2x} = 5$

$\therefore 152x + 3800 = 15950 - 10x$

$\therefore 162x = 12150$

$81x = 6075$

$9x = 675$

$x = 75$. ∴ length = 75 + 25 = 100 mm. = **1 decim.**

(21) 10 litres of gas are measured off at a pressure = 800 mm. of mercury. What volume will they occupy under normal pressure?

Given that 10 litres of gas are measured under 800 mm.

It is required to find what volume they occupy under normal pressure.

Normal pressure = 760 mm. mercury.

Under a pressure of 800 mm. the gas has a volume of 10 litres.

" " 1 " " " " 10×800 "

" " 760 " " " " $\frac{10 \times 800}{760}$

$= \frac{2000}{190} = 10{\cdot}526$ **litres.**

(22) To what additional pressure must 1 litre of gas under 760 mm. be subjected to reduce its volume to 3 decilitres?

Given that 1 litre of gas under 760 mm. is reduced to 3 decilitres.

It is required to find the pressure.

3 decilitres = $\frac{3}{10}$ litre.

Volume of gas is 10 decilitres under pressure of 760 mm.

" " 1 " " " " 760×10

" " 3 " " " " $\frac{760 \times 10}{3}$

$= \frac{7600}{3} = 2533\frac{1}{3}$

∴ the additional pressure is $2533\frac{1}{3} - 760 = \mathbf{1773\frac{1}{3}}$ **mm.**

(23) 5 litres of gas are measured over water, and the level of the water outside is 405 mm. higher than the level of the water inside the gas-jar. What would be the volume of the gas under normal pressure? Barometer at 770. Specific gravity of mercury, 13·5.

Given that 5 litres of gas are measured over water, and that the water outside exerts a pressure = weight of column of water 405 mm. high, the barometer standing at 770 mm.

It is required to find the volume of the gas, under pressure = 760 mm. mercury.

The gas is under a pressure of 770 mm. due to the atmosphere, and $\frac{405}{13{\cdot}5} = 30$ mm. mercury; total 800 mm. mercury.

Under pressure 800, volume of gas is 5 litres.

" " 1 " " " 5×800

" " 760 " " " $\frac{5 \times 800}{760} = \frac{5 \times 20}{19}$

$= \frac{100}{19} = \mathbf{5\frac{5}{19}}$ **mm.**

(To be continued.)

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A MONTHLY EDUCATIONAL JOURNAL.

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ANSWERS TO
Pupil Teachers' Examination Papers.
MAY 31ST, 1884.
FIRST YEAR.
Pupil Teachers at end of First Year.

Three hours and a half allowed.

Arithmetic.

MALES.

1. Reduce to a fraction $\frac{1}{6}+\frac{9}{10}$ of $\frac{3}{15}+\frac{\cdot0375}{6\cdot25}$; and find the value of $\cdot0324\times\cdot085\div4\cdot86$.

$\frac{1}{6}+\frac{9}{10}$ of $\frac{3}{15}+\frac{\cdot0375}{6\cdot25}$

$=\frac{1}{6}+(\frac{9}{10}\times\frac{3}{15})+(\frac{375}{10000}\times\frac{100}{625})$

$=\frac{1}{6}+\frac{3}{50}+\frac{3}{500}$

$=\frac{500+180+9}{1500}$

$=\frac{689}{1500}$. Ans.

$\cdot0324$
$\cdot085$
1620
2592
$4\cdot86)\cdot0027540(\underline{\cdot00056}$. Ans.
2430
3240
2916
324

2. Find the value in money of 2·0175 of £6 5s. + ·3125 of half a guinea − ·08$\dot{3}$ of 2¼d.

	£	£	s.	d.
2·0175 of £6 5s. = 2·0175 × 6·25 =		12	12	2¼
·3125 of half a guinea = ·3125 × 10·5 =		0	3	3⅜
	£	12	15	5⅝
·08$\dot{3}$ of 2¼d. = $\frac{75}{900}\times\frac{9}{4}$d. =		0	0	$0\frac{9}{16}$
	£	12	15	$5\frac{7}{16}$. Ans.

3. Give a rule for finding the decimal point in dividing one decimal by another, and illustrate your rule by dividing ·675 by ·000625.

Rule.—Subtract the no. of decimal places in the divisor from the no. in the dividend, and mark off the difference in the quotient.

If the no. in the dividend is less than the no. in the divisor, o's must be added and brought down, till the subtraction can be made.

$\cdot000625)\cdot675000(\underline{1080}$. Ans.
625
5000
5000
0

4. A man after selling ⅘ of $\frac{7}{16}$ of his share in a ship finds that he owns $\frac{5}{64}$ of the ship. What part of it did he own at first?

⅘ of $\frac{7}{16}=\frac{28}{160}$ of share sold.

$1-\frac{28}{160}=\frac{132}{160}$,, kept.

$\frac{132}{160}:1::\frac{5}{64}:\underline{\frac{10}{160}}$. Ans.

FEMALES.

1. What will be the cost of 3 lbs. 9 ozs. 17 dwts. 12 grs. at 20 guineas per lb.?

	£	s.	d.	
6 ozs. = ⅜ lb.	21	0	0	= Cost of 1 lb.
		3		
	63	0	0	= ,, 3 lbs.
3 ozs. = ½ of 6 ozs.	10	10	0	= ,, 6 ozs.
10 dwts. = ½ of 3 ozs.	5	5	0	= ,, 3 ozs.
5 dwts. = ½ of 10 dwts.	0	17	6	= ,, 10 dwts.
2 dwts. = ⅖ of 10 dwts.	0	8	9	= ,, 5 dwts.
12 grs. = ⅙ of 2 dwts.	0	3	6	= ,, 2 dwts.
	0	0	$10\frac{1}{2}$	= ,, 12 grs.
	£80	5	$7\frac{1}{2}$	= ,, 3 lbs. 9 ozs. 17 dwts. 12 grs. Ans.

2. Add together $103\frac{1}{11}$, $1\frac{8}{11}$, $204\frac{1}{11}$, and $2\frac{1}{11}$.

$103\frac{1}{11}+1\frac{8}{11}+204\frac{1}{11}+2\frac{1}{11}$

$=310\frac{44+30+33+16}{48}$

$=310\frac{123}{48}$

$=312\frac{3}{48}$

$=312\frac{1}{16}$. Ans.

3. Find the number of miles in the radius of the earth, having given that it is the least number which is divisible by 2, 3, 4, 5, 6, 8, 9, 10, 11, and 12.

The least No. divisible by these Nos. is their L.C.M.

2	2, 3, 4, 5, 6, 8, 9, 10, 11, 12
3	4, 9, 5, 11, 6
	4, 3, 5, 11, 2

L.C.M. = 2 × 3 × 4 × 3 × 5 × 11 = 3960. Ans.

4. Make out the following bill:

7 doz. and 4 eggs at 9d. a dozen.
19 lbs. of soap at 5½d. per lb.
18 lbs. of butter at 1s. 2d. per lb.
13½ lbs. of cheese at 7½d. per lb.
8 four-lb. loaves at 4½d. each.
½ lb. of pepper at 1½d. per oz.

11, Market Street, Manchester,
31st May, 1884.

Mrs. Granger,

Bought of Henry Field.

	£	s.	d.
7 doz. and 4 eggs at 9d. a doz.	0	5	6
19 lbs. of soap at 5½d. per lb.	0	8	8½
18 lbs. of butter at 1s. 2d. per lb.	1	1	0
13½ lbs. of cheese at 7½d. per lb.	0	8	5½
8 four-lb. loaves at 4½d. each	0	3	0
½ lb. pepper at 1½d., per oz.	0	0	10
	£2	7	5½

Grammar.

MALES AND FEMALES.

1. Cowards die many times before their death.
The valiant only taste of death but once —
SHAKESPEARE.

Analyse these lines and parse them.

2. Point out any *English* terminations in them; and give instances of words with a similar ending.

Sentence.	Kind of Sentence.	Subject.	Predicate.	Object.	Extension.
(*a*) Cowards die many times before their death,	P.S.	Cowards	die		many times before their death (time)
(*b*) The valiant only taste of death but once.	P.S.	The valiant only	taste	of death (Ins.)	but once (time)

Cowards—noun, com., masc., plu., 3rd, nom. to 'die.'
die—verb, reg. intrans., act., ind., pres., 3rd, plu., agreeing with its nom. 'cowards.'
many—adj., indef. numl., qualifying 'times.'
times—noun, abs., neut., plu., 3rd, obj. of time to 'die.'
many times—advl. phrase (time), qualifying 'die.'
before—prep., showing the relation between 'death' and 'die.'
their—per. pro., masc., plu., 3rd, poss., gov. by 'death.'
death—noun, abs., neut., sing., 3rd, obj., gov. by 'before.'
the—adj. of distinction, pointing out 'valiant.'
valiant—adj., used as com. noun, masc., plu., 3rd, nom. to 'taste.'
only—adj. of quality, qual. 'valiant.'
taste—verb, reg. intrans., act., ind., pres., 3rd, plu., agreeing with its nom. 'valiant.'
of—prep., showing relation between 'death' and 'taste.'
death—noun, abs., neut., sing., obj., gov. by 'of.'
but—adv. of deg., qual. 'once.'
once—adv. of time., qual. 'taste.'

2. *-ard* in *cowards;* drunkard, laggard, dastard.
-th in *death* (from die); mirth, earth, berth, length.
-y in *many;* wealthy, mighty, any, dreary.
-ce in *once;* hence, thence, whence.
-ly in *only;* badly, purely, wilfully.

3. What is meant by 'Mood,' and how many 'Moods' are there? Write out the Imperative Mood of the verb 'to die.'

Mood is the inflexion which a verb undergoes to show the mood or manner in which the action is presented to the mind.
Some grammarians say *five*, others *four*.
By the first the *Potential* is considered a mood, by the latter the auxiliaries which are said to form the Potential Mood are treated as auxiliaries of the Indicative and Subjunctive Moods.

To die.
Imperative Mood.

Singular.	*Present Tense.*	*Plural.*
2. *Die* (thou.)		2. *Die* (ye or you.)

Geography.

1. Draw a full map of Northumberland, Durham, and Yorkshire.

N.B.—Insert the lines of latitude and longitude.

2. Describe, as for children, the formation of springs and the course of a river; showing how and why it widens and deepens as it goes on, and explaining the geographical terms which are applied to it. Illustrate by examples.

Snow and rain fall on the hills and mountains. Some of the rain runs down the slopes. Little rills from all the hollows between the hills join together and form a stream. Some of the rain and the melted snow find their way into the ground. This water sinks till it comes to a hard rock or bed of clay, through which it cannot pass. It gathers into a great mass, till at last it forces its way through some crack or crevice to the surface of the ground. Here it bubbles up and forms a spring. (Draw diagram on blackboard.) The water overflows, and joining the rills, or being joined by them, makes the stream. The place where the river rises is called its *source*, and the little rills which feed the stream by flowing into it are called *feeders*, *tributaries*, or *affluents*. Where one of these joins the larger stream is called the *confluence*. The hollow worn out by the water is called the *bed;* the land on either side, the *banks;* the whole country drained by the river, the *basin;* and the place where it joins the sea, the *mouth*. If the water divides as it nears the sea, the land between the mouths is called *a delta*. (Show on map or draw on blackboard a map of any river, say the *Thames*. Point to Cotswold Hills, Kennet, Wey, Mole, etc., and the estuary.)

3. Describe the position and character of Quebec, Montreal, Ottawa, Winnipeg, St. John's, and Halifax.

Quebec, on a bold rocky plateau on the north bank of the St. Lawrence, about 340 miles from its mouth. It is strongly fortified, and has great trade. Capital of Quebec province.
Montreal, on the S.E. side of the island of the same name, near the confluence of the Ottawa and the St. Lawrence, in the province of Quebec. It is the largest town of the dominion.
Ottawa, capital of the dominion of Canada, at the junction of the Rideau Canal and the Ottawa river. Has a population of 25,000.
Winnipeg, capital of the province of Manitoba, about forty miles south of Lake Winnipeg, and on the Red River. A seat of the fur, lumber, and grain trade.
St. John's, on the S.E. coast of Newfoundland, of which it is the capital. Strongly fortified, and engaged in fisheries.
Halifax, on the S.E. coast of Nova Scotia, of which it is the capital. It has a splendid harbour, which is the chief British naval station in America.

History.

1. In the time of Alfred three different nations occupied this country; tell who they were, and in what districts they were severally found.

The three different nations occupying this country in the time of Alfred were the Ancient Britons, the Saxons, and the Danes.
The Britons occupied Wales, Cornwall, and part of Devon, Cumberland, Westmoreland, and Lancashire.
The Saxons occupied the south, south-east, and centre of the country.
The Danes were possessed of East Anglia and Northumbria, stretching as far inland as Watling Street.

2. With what letter do the names of most of our Saxon kings begin? Write down at least five such names and give the dates of their reigns.

The letter *E*.

	A.D.
Egbert	827—836
Ethelwulph...	836—857
Ethelbald	858—860
Ethelbert	860—866
Ethelred	866—871
Edmund	941—946
Edred	946—955
Edwy	955—959
Edgar	959—975
Edward	975—979
etc.	

3. What were the distinguishing ranks of society in the tenth century? Describe their condition.

The principal person in the kingdom was the King, elected to that office by the Great Council. After the king came, the Eldermen, or Earls, who ruled their districts called shires, and led their armies to battle on behalf of their king and country. Then came the lower nobles, called Thanes, owning at least five hides of land. Ceorls were the last class of freemen, and the burghers of the towns were engaged in trade. Two-thirds of the people were in a state of great degradation amounting to slavery. Sale and purchase of men were quite common. The people lived on the lands of their lord, and were not allowed to remove without permission. The life of all the Anglo-Saxons would now be considered savage, and there were none of the refinements of the present day, either in home, or dress, or food.

Composition.

Write from memory the substance of the passage read to you by the Inspector.

There is a story told of Saint Anselm, that he was out riding one day, after he had become Archbishop of Canterbury, when the young men of his train started and chased a hare with their dogs. The hare took refuge under Anselm's horse. Anselm reined in his horse; the young men crowded round with noisy triumph at the capture, but Anselm forbade them to touch the hare. 'You laugh,' he said, 'but for the poor creature there is nothing to laugh at; its mortal foes are about it, and it flies to us, beseeching for shelter. It is an image of the departing soul of man, hunted by its enemies the evil spirits.' Then he rode on, and with a loud voice forbade both men and dogs to pursue the hare; and the creature, glad and at liberty, darted off to the fields and woods.

Needlework.

FEMALES.

One hour will be allowed for this exercise in the afternoon.

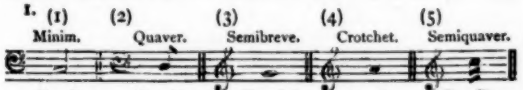
Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write above each of the following notes its value-name (semibreve, &c.), and below each its pitch-name.

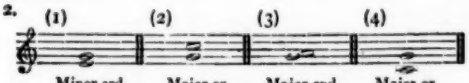
1. (1) Minim. (2) Quaver. (3) Semibreve. (4) Crotchet. (5) Semiquaver.



C or Do. D or Re. G or Sol. A or La. C or Do.

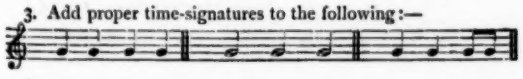
2. Write below each of the following intervals its name (major third, &c.):—

2. (1) (2) (3) (4)

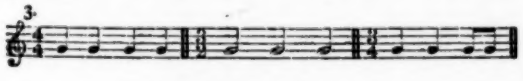


Minor 3rd. Major or Perfect 4th. Major 2nd. Major or Perfect 5th.

3. Add proper time-signatures to the following:—



3.



TONIC SOL-FA NOTATION.

1. Write a six-pulse tone, using two-pulse measures.

1. |d :— |— :— |— :— ‖

2. Write the names of the following intervals:—(1) *me* to *soh*; (2) *soh* to *doh*^{1}; (3) *soh* to *lah*; (4) *doh* to *soh*.

2. (1) Minor 3rd; (2) Major or Perfect 4th; (3) Major 2nd; (4) Major or Perfect 5th.

3. Write the following an octave higher:—

	m_1	d_1	m_1	s_1	l_1	t_1	d
3.	m	d	m	s	l	t	d^1

SECOND YEAR.

Pupil Teachers at end of Second Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

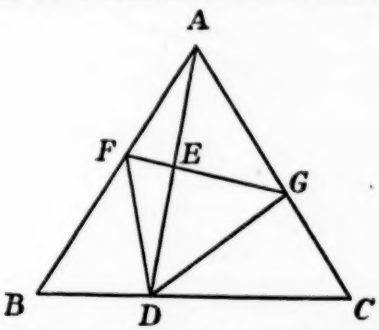
1. If two triangles have two sides of the one equal to two sides of the other, each to each, and have likewise the angles contained by those sides equal to each other; they shall likewise have their bases or third sides equal, and the two triangles shall be equal, and their other angles shall be equal, each to each, viz., those to which the equal sides are opposite.

Euclid, Book I., Prop. 4.

2. If two triangles have two sides of the one equal to two sides of the other, each to each, but the base of one greater than the base of the other; the angle contained by the sides of the one which has the greater base, shall be greater than the angle contained by the sides, equal to them, of the other.

Euclid, Book I., Prop. 25.

3. In the base BC of a triangle ABC any point D is taken. Draw a straight line such that if the triangle ABC be folded about this straight line, the point A shall fall on the point D.



In the given triangle ABC, join AD, and bisect AD in E. Through E draw FG at right ∠s to AD, meeting AB and AC in F and G. FG is the line required.

Join FD, GD.

Because in the two △s DEF, AEF, DE=AE (Const.) and EF is common, the two sides DE, EF=two sides AE, EF, each to each; and the ∠AEF=∠DEF (Const.), ∴ base DF=base AF; and ∠FAE=∠FDE (I. 4.)

In like manner it may be shown that AG=GD and ∠GAE=∠GDE.

∴ whole ∠GAF=whole ∠GDF.

Wherefore if the △ AFG be folded about the line FG, it will coincide with the △ FDG, and the point A will coincide with the point E (I. 4.) Q. E. F.

Arithmetic.

FEMALES.

1. To the sum of $2\frac{1}{2}$ and $3\frac{3}{4}$ add the difference between $4\frac{3}{5}$ and $5\frac{1}{4}$, and multiply the result by the quotient of $7\frac{9}{10}$ divided by $6\frac{2}{3}$.

$$(2\tfrac{1}{2}+3\tfrac{3}{4})+(5\tfrac{1}{4}-4\tfrac{3}{5})\times(7\tfrac{9}{10}\div 6\tfrac{2}{3})$$
$$=\left(5\frac{3+4}{6}\right)+\left(1\frac{16-15}{20}\right)\times\left(\tfrac{79}{10}\times\tfrac{3}{20}\right)$$
$$=(6\tfrac{1}{2}+1\tfrac{1}{20})\times\tfrac{237}{200}$$
$$=7\frac{10+3}{60}\times\tfrac{237}{200}$$
$$=\tfrac{433}{60}\times\tfrac{237}{200}$$
$$=\underline{8\tfrac{111}{1111}}. \text{ Ans.}$$

2. Express as decimals $\frac{3}{800}$ and $\frac{33}{1000}$.

$$=\underline{\cdot 000\tfrac{3}{8}}. \text{ Ans.} \qquad =\frac{2\cdot 3}{16}$$
$$=\underline{\cdot 00375}. \text{ Ans.} \qquad =\underline{\cdot 14375}. \text{ Ans.}$$

3. Find the difference between $1\frac{3}{4}$ of £1 13s. 9d, and $\frac{3}{7}$ of £5 18s. 5d., and reduce the result to the fraction of a guinea.

$$\frac{1\frac{3}{4} \text{ of £1 13s. 9d.} - \frac{3}{7} \text{ of £5 18s. 5d.}}{1 \text{ guinea}}$$
$$= \frac{\frac{7}{4} \times 41\frac{3}{4} - \frac{3}{7} \times 118\frac{1}{4}}{252}$$
$$= \frac{675 - 609}{252}$$
$$= \frac{1}{4}. \text{ Ans.}$$

4. Find the cost of carpeting a room 34 ft. 9 in. long, by 26 ft. 6 in. wide, at 4s. 6d. per sq. yd.

$$(34\frac{3}{4} \times 26\frac{1}{2} \div 9) \times 4\frac{1}{2}\text{s.}$$
$$= \frac{139}{4}{}^{10} \times \frac{53}{2} \times \frac{1}{9} \times \frac{9}{2}$$
$$= \frac{7367}{8}$$
$$= £23\ 0s.\ 5\frac{1}{2}\text{d. Ans.}$$

Grammar.

MALES AND FEMALES.

1. Immortal *glories* in my mind *revive*,
And in my soul *a thousand passions strive*,
When Rome's *exalted beauties* I *descry*,
Magnificent in piles of ruin *lie*. ADDISON.

Analyse the above, parsing the words in italics.

2. Point out any Latin prefixes in the above, and give their meanings; and instance other words in which they occur.

ANALYSIS.

Sentence.	Kind of Sent.	Connective.	Subject.	Pred.	Object.	Extension.
(*a*) Immortal glories in my mind revive	Princ. Sent.		Immortal glories	revive		in my mind (*place*)
(*b*) and in my soul a thousand passions strive	Princ. coord. with (*a*)	and	a thousand passions	strive		in my soul (*place*)
(*c*) When Rome's exalted beauties I descry, magnificent in piles of ruin lie	Adv. S. (time) to (*a*) and (*b*)	when	I	descry	Rome's exalted beauties m'gnific'nt in piles of ruin lie.	

PARSING.

Glories—noun, abs., neut., plur., 3rd, nom. to 'revive.'
revive—verb, reg. intrans., act., ind., pres., plur, 3rd, agreeing with 'glories.'
a—adj. of distinction, limiting 'thousand.'
thousand—adj. of number, qualg. 'passions.'
a thousand—comp. adj., qualg. 'passions.'
passions—noun, abs., plur., neut., 3rd, nom. to 'strive.'
strive—verb, irreg. intrans., act., pres., plur., 3rd, agreeing with 'passions.'
when—advl. conj., joining 'glories revive' and 'I descry.'
exalted—partl. adj. of quality, qualg. 'beauties.'
beauties—noun, com., neut., plur., 3rd, obj., gov. by 'descry.'
descry—verb, reg. trans., act., ind., pres., 1st, sing., agreeing with 'I.'
magnificent—adj. of quality, qualg. 'beauties.'
lie—verb, irreg. intrans., act., inf., pres., gov. by 'descry.'

3. Paraphrase the following:—

He that holds fast the golden mean,
And lives contentedly between
The little and the great,
Feels not the wants that pinch the poor,
Nor plagues that haunt the rich man's door,
Imbittering all his state.

The man who is wise enough to be perfectly contented with a medium position in life, without aspiring to be great or fearing to be little, is preserved from feeling the pangs of hunger and the sore needs of the poor; while he is also free from the petty annoyances which continually surround the home and mar the happiness of the rich.

Geography.

(Answer Two Questions.)

1. Draw a map, showing the coast-line of the Baltic Sea, and full physical features of Norway and Sweden.
N.B.—Insert the lines of latitude and longitude.

2. What causes affect climate? Give illustrations from the different British possessions.
Among the principal causes which affect climate are:—
(*a*) *Nearness to the Equator.*—Countries near are hotter than those more remote; thus India is hotter than Cape Colony, and Cape Colony than Canada.
(*b*) *Proximity to the sea.*—The sea moderates the climate; lands near the sea are moister and more temperate than those inland; thus British Columbia has more rain and is milder than Quebec.
(*c*) *Elevation.*—Mountainous countries are colder than flat, low-lying countries. Europeans go to the hills during the hot season in India to escape the heat of the plains.
(*d*) *Direction of the mountain-chains, and general slope of the country.*—Mountain-chains may be so placed as to moderate the climate whether as regards heat or cold, as the Himalayas do in India.
(*e*) *Cultivation, character of the soil, etc.*—Presence of trees alter the amount of moisture. Where planted, as in Cape Colony, or some districts of Australia, the climate is more moist.

3. Describe fully the basin of the Ganges.
The basin of the Ganges embraces an area of nearly 400,000 square miles, and extends from the Himalayas in the north to the Vindhyas in the south, and from the high lands separating it from the basin of the Indus in the west to the Bay of Bengal in the east. The river rises in the Himalayas at a height of 11,000 feet, and flows through the range for a distance of two hundred miles. On entering the great plain it is not more than 1000 feet above the level of the sea, and the basin is thus remarkably flat for nearly 1300 miles. The basin includes numerous tributaries to the main stream, among others being the Jumna from the Himalayas and the Sone from the Vindhyas on the right bank, and the Goomtee, Gunduck, and Godra, on the left, are from the Himalayas.
At a considerable distance from the sea the river forms many mouths, and receives the Brahmapootra, the lower course of which is thus included in the Ganges basin, which is very fertile, and covered with a vast population in large cities and towns, Calcutta, Delhi, Benares, Patna, and Allahabad, being the chief.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination papers.

Arithmetic.

MALES.

1. If I get £5 12s. 6d. for the loan of £375 for 4 months, what rate per cent. per annum of interest do I get?

$$\text{Rate for £375 for 4 mos.} = 5\frac{1}{2}$$
$$\text{,, } 1 \text{ ,, } 1 \text{ ,, } = \frac{5\frac{1}{2}}{375 \times 4}$$
$$\text{,, } 100 \text{ ,, } 12 \text{ ,, } = \frac{5\frac{1}{2} \times 100 \times 12}{375 \times 4}$$
$$= 4\frac{1}{2}. \text{ Ans.}$$

2. If I invest £2925 in railway stock at $97\frac{1}{2}$, what would I lose in capital if the stock fell to $95\frac{3}{4}$? (Omit brokerage.)

$$97\frac{1}{2} - 95\frac{3}{4} = 1\frac{3}{4}$$
$$\text{Loss on £}97\frac{1}{2} = 1\frac{3}{4}$$
$$\text{,, } 1 = \frac{1\frac{3}{4}}{97\frac{1}{2}}$$
$$\text{,, } 2925 = \frac{1\frac{3}{4} \times 2925}{97\frac{1}{2}}$$
$$= £52\ 10s. \text{ Ans.}$$

3. A merchant has four ships, the 1st of which brings him a profit of £1200 in 10 months, the 2nd £1500 in 12 months, the 3rd £700 in 9 months, and the 4th a loss of £500 in 8 months. Find his average gain per month.

Profit per mo. on 1st = $\frac{1200}{10}$ = £120
,, 2nd = $\frac{1000}{12}$ = 125
,, 3rd = $\frac{100}{9}$ = $77\frac{7}{9}$
Total gain = $322\frac{7}{9}$
Loss per mo. on 4th. = $\frac{800}{8}$ = $62\frac{4}{9}$
£260$\frac{8}{11}$. Ans.

4. If the true discount on a bill of £387 10s. be £12 10s., interest being at 5 per cent. per annum, in how many months will the bill be due?

Present worth = £387 10s. − £12 10s. = £375.
Int. on £375 for 1 year at 5 per cent. = £18 15s.
£ s. £ s. mos. mos.
18 15 : 12 10 :: 12 : 8. Ans.

History.

MALES AND FEMALES.

1. Under the feudal system what were the chief advantages claimed by the lord?

(*a*) He claimed *homage* from the vassal, who swore *fealty* to his lord, and assisted him against his enemies.
(*b*) Also *aids* on special occasions.
(*c*) *Reliefs* or payments made by vassals on succeeding to the estates of their predecessors.
(*d*) He had the power to give wards in marriage.
(*e*) He exacted *fines* when land was alienated.
(*f*) He *escheated* the property when the vassal left no heirs.

2. When and for how long did Richard II. reign? Tell the names and nationality of his wives, and compare his character with that of his father.

Richard II. reigned from 1377 to 1399. He married (1) Anne of Bohemia; (2) Isabella of France. Richard had some ability, but was of a violent temper and deficient in judgment, both qualities rendering him unfit to reign. When he did assert his will his conduct became tyrannical. On the other hand, the Black Prince, his father, was of a brave, prudent, active, and warlike disposition. When he died he had the reputation of possessing all the virtues of perfect chivalry, although the latter part of his life was marred by some instances of cruelty.

3. When did Cade's insurrection occur, and what complaints were then made by the people?

In the reign of Henry VI., 1450. The people of Kent whom he led complained that it was rumoured Kent was to be desolated because of Suffolk's death, that prosperity was driven from the land by misgovernment, that the people were not paid for stuff taken for the King's use, that places of trust were filled by mean and corrupt persons, that they had been greatly overtaxed, that the sheriffs were guilty of extortion, and that they had not been allowed freely to elect Members of Parliament.

Teaching.

What common mispronunciations are to be found in your district, and how would you correct them in a reading lesson?

Note.—The answers to this question would be very varied, according to the districts in which the examinations were held. The following is an example for one district only.

The principal mispronunciations in this district are of words in which the letter *r* occurs, words like length and strength, the *g* being left out, words ending in *-een* and *-eing* being similarly pronounced, and words in *-ealm* being made into two syllables.

To correct the first, practice is given with an exaggerated sound of the letter in pronouncing the syllables *ar, er, ir, or, ur;* the position of the tongue is shown, and all words are spoken slowly. With the letter *g* the words are divided into two sounds, the *leng* being said first and the sound of *-th* added. In *been* and *being* the hard sound of the *g* is made prominent till the distinction is seen. Practice in slow pronunciation and imitation of the teacher's pattern voice and formation of mouth correct the latter.

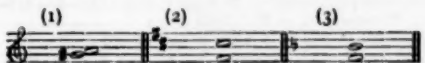
Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write below each of the following intervals its name (minor third, &c.):—

1.

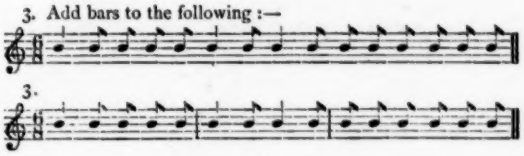


Minor 2nd. Major or Perfect 5th. Major or Perfect 4th.

2. Write the scale of A major, placing the necessary sharps before the notes to be sharpened.

2.

3. Add bars to the following:—



3.

TONIC SOL-FA NOTATION.

1. What is the interval (major third, &c.) (1) between *te* and *doh'*; (2) between *me* and *te*; (3) between *doh* and *fah*?

1. (1) Minor 2nd; (2) Major or Perfect 5th; (3) Major or Perfect 4th.

2. What is the mental effect (1) of *me*? (2) of *soh*?

2. (1) Steady, calm, placid; (2) grand, bold, and bright.

3. Write (1) the pulse signs for a four-pulse measure; (2) a six-pulse measure.

3.
(1) | : | : ‖ (2) | : : | : : ‖

THIRD YEAR.

Pupil Teachers at end of Third Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 3, if you can.

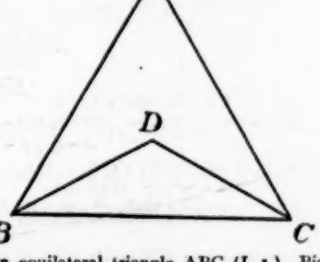
1. Straight lines which are parallel to the same straight line are parallel to each other.

Euclid, Book I., Prop. 30.

2. If a parallelogram and a triangle be upon the same base, and between the same parallels; the parallelogram shall be double of the triangle.

Euclid, Book I., Prop. 41.

3. Construct a triangle having the vertical angle four times each of the angles at the base.



Describe an equilateral triangle ABC (I. 1.) Bisect each of the ∠'s ABC, ACB by BD, CD meeting in D (I. 9.)

Then △DBC shall have its vertical ∠ double of each of the ∠'s DBC, DCB.

Since every equilateral △ is equiangular (Cor. I. 5), and the three ∠'s of every △ = two right ∠'s;

∴ each of the ∠'s of △ABC = ⅓rd of two right ∠'s;

∴ also DBC, DCB each = ½th of two right ∠'s, and together they = ⅓rd of two right ∠'s;

∴ remg. ∠ BDC of △DBC = ⅔rds, or ⅓ths of two right ∠'s.

i.e. the ∠ BDC = four times each of the ∠'s DBC, DCB.

Q. E. F.

Algebra.

(*Answer two Questions, including Question 2, if you can.*)

1. If $a=3$, $b=4$, $c=5$, $d=6$, find the numerical value of—

$$\frac{(a+b)(c+d)-(b+c)(d+a)}{ab-bc+cd-da}$$

and also of $\dfrac{2\sqrt{a^2+b^2}+\sqrt[3]{a^3+b^3+c^3}}{d-c+b-a}$

(*a*)
$$\frac{(a+b)(c+d)-(b+c)(d+a)}{ab-bc+cd-da}$$
$$=\frac{(3+4)(5+6)-(4+5)(6+3)}{12-20+30-18}$$
$$=\frac{77-81}{42-38}$$
$$=\frac{-4}{4}$$
$$=\underline{-1.}\ \text{Ans.}$$

(*b*)
$$\frac{2\sqrt{a^2+b^2}+\sqrt[3]{a^3+b^3+c^3}}{d-c+b-a}$$
$$=\frac{2\sqrt{9+16}+\sqrt[3]{27+64+125}}{6-5+4-3}$$
$$=\frac{10+6}{2}$$
$$=\underline{8.}\ \text{Ans.}$$

2. State and prove the rule for finding the L.C.M. of two expressions, and find the L.C.M. of $9x^3-x-2$ and $3x^3-10x^2-7x-4$.

Rule.—Divide one of the expressions by their G.C.M. Then multiply the quotient and the other expression together; the product will be the L.C.M., or—

Divide each of the expressions by the G.C.M. Then mult. the quotients and the G.C.M. for the L.C.M.

If two numbers are prime to each other, the only no. which will contain them is their product. But if two nos. have a common factor, then the least no. which will contain them both must contain not only those parts of them which are prime to each other but their G.C.M.

For let $a=cx$ and $b=cy$. Then x and y are prime to each other, and c is common, and the least multiple to contain cx and cy is cxy. But c is the G.C.M. of a and b, and x and y are the parts prime to each other.

And $cxy=ay=bx=\dfrac{ab}{c}$.

$3x^3-10x^2-7x-4)9x^3-\ x\ -2\ (3$
$\quad 9x^3-30x^2-21x-12$
$\quad 10)30x^2+20x+10$
$\quad 3x^2+\ 2x+\ 1)3x^3-10x^2-7x-4(x-4$
$\quad 3x^3+\ 2x^2+\ x$
$\quad -12x^2-8x-4$
$\quad -12x^2-8x-4$

G.C.M. $=3x^2+2x+1$

$3x^2+2x+1)3x^3-10x^2-7x-4,\ 9x^3-x-2$

$x-4,\ 3x\ -2$

L.C.M. $=(3x^2+2x+1)(x-4)(3x-2)$
$=(9x^3-x-2)(x-4)$
$=\underline{9x^4-36x^3-x^2+2x+8.}$ Ans.

3. A farmer sold to one person six more than one fourth of his sheep, to another one fifth of the remainder, and to a third two more than one sixth of those now left. If he has still eighteen unsold, how many had he at first?

Let x = No. he had at first,

then $\frac{x}{4}+6$ = No. in first sale,

and $\frac{3}{4}x-6$ = No. after first sale

then $\frac{1}{5}(\frac{3}{4}x-6)$ = No. in second sale

and $\frac{4}{5}(\frac{3}{4}x-6)$ = No. after second sale

then $\frac{1}{6}$ of $\frac{4}{5}(\frac{3}{4}x-6)+2$ = No. in third sale

and $\frac{5}{6}$ of $\frac{4}{5}(\frac{3}{4}x-6)-2=18$, No. after third sale.

$$\frac{x-8}{2}-2=18$$
$$x-8-4=36$$
$$\underline{x=48.}\ \text{Ans.}$$

Mensuration.

The area of a square field is equal to the area of a rectangle whose sides are 21 ft. 11 in. and 197 ft. 3 in.; find the side of the square.

21 ft. 11 in. × 197 ft. 3 in.
= 263 × 2367
= 622521 sq. inches.
$\sqrt{622521}$
= 789 inches
= 65 feet 9 inches. Ans.

Arithmetic.

FEMALES.

1. Simplify $\dfrac{4\cdot4+\frac{3}{5}}{7\cdot375-\frac{1}{8}+\frac{3}{4}}$ and express your answer *decimally*.

$$\frac{4\cdot4+\frac{3}{5}}{7\cdot375-\frac{1}{8}+\frac{3}{4}}$$
$$=\frac{4\cdot4+\cdot6}{7\cdot375-\cdot125+\cdot75}$$
$$=\frac{5}{8}$$
$$=\underline{\cdot625.}\ \text{Ans.}$$

2. Reduce $\frac{2}{3}$ of a guinea + $\frac{1}{4}$ of $\frac{2}{3}$ of £1 + $\frac{4}{5}$ of $\frac{3}{4}$ of a crown + $\frac{1}{3}$ of $\frac{5}{6}$ of 1s. to decimals of £1 and of £100.

$$\left.\begin{array}{rl} & \text{s.} \\ \frac{2}{3}\text{ gui.} = \frac{2}{3}\times\frac{21}{1} = \frac{14}{1} = & \frac{14\cdot0}{1\cdot0} \\ \frac{1}{4}\text{ of }\frac{2}{3}\text{ of £1} = \frac{1}{4}\times\frac{2}{3}\times\frac{20}{1} = & \frac{5\cdot0}{1\cdot0} \\ \frac{4}{5}\text{ of }\frac{3}{4}\text{ of a cr.} = \frac{4}{5}\times\frac{3}{4}\times\frac{5}{1} = & \frac{3\cdot0}{1\cdot0} \\ \frac{1}{3}\text{ of }\frac{5}{6}\text{ of 1s.} = & \frac{0\cdot8}{1\cdot0} \end{array}\right\} = \frac{22\cdot8}{1\cdot0}\text{s.}$$

$\frac{22\cdot8}{1\cdot0}$s. to the dec. of £1 = $\frac{22\cdot8}{1\cdot0}\times\frac{1}{20}=\frac{22\cdot8}{20\cdot0}=\underline{\cdot74375}$. Ans.

To dec. of £100 = ·74375 ÷ 100 = ·0074375. Ans.

3. A man undertakes a journey. He walks ½ of the distance the first day; ·25 of what remained on the second day; ·3 of what still remained on the third day, thus leaving 12 miles for the fourth day. What was the length of the journey?

First day walked ½ left ½
Second day walked ·25 of ½ = ¼ left = ½ − ¼ = ¼
Third day walked ·3 of ¼ = ¾ of ¼ = 3/10 left = ¼ × 7/10 = 7/40
∴ 7/40 = 12 miles
40/40 = 12 × 40 = 480/40 miles. Ans.

4. What is a *decimal* fraction? State and *prove* the rule for converting a decimal into a vulgar fraction, and apply your rule to the conversion of ·207 into a vulgar fraction.

A decimal fraction is one whose denominator is 10 or a power of 10, the denominator being known by fixing a point as many figures to the right of the numerator as there are cyphers in the denominator.

Write as many 0's prefixed by 1 as there are decimal places in the number.

$$\cdot207=\tfrac{207}{1000}.$$

Since a figure one step to the right from the units' place is $\frac{1}{10}$th the value of the same figure in the units, and in the second place $\frac{1}{100}$th, and in the third place $\frac{1}{1000}$th, it follows that ·207 = $\frac{2}{10}$, $\frac{0}{100}$, and $\frac{7}{1000}$. The common denominator of these fractions is 1000, and when reduced the numbers are 200, 0, 7, which, added, yield $\frac{207}{1000}$.

Grammar.

MALES AND FEMALES.

1. An *inadvertent* step *may crush* the snail,
That crawls at *evening* in the public path;
But *he that* has *humanity*, *forewarned*,
Will tread aside and *let* the reptile *live*.

Analyse the above passage, parsing the words in italics.

ANALYSIS.

Sentence.	Kind of Sent.	Connective.	Subject.	Predicate.	Object.	Extension.
(*a*) An inadvertent step may crush the snail	P.S.		An inadvertent step	may crush	the snail	
(*b*) that crawls at evening in the public path	Adj. to *snail* in (*a*)	*In rel*	that	crawls		at evening (*time*) in the public path (*place*)
(*c*) but he, forewarned, will tread aside	P.S. advers. to (*a*)	but	he, forewarned	will tread		aside (*place*)
(*d*) and let the reptile live	Princ. co-ord. with (*c*)	and	[he]	will let	the reptile (to) live	
(*e*) that has humanity	Adj. to *he* in (*c*)	*In rel.*	that	has	humanity	

PARSING.

Inadvertent—Adj. of quality, qual. 'step.'
may—aux. verb to 'crush,' indicating pot. mood.
crush—verb, reg. trans., act., inf., gov. by 'may.'
may crush—verb, reg. trans., act., pot., pres., 3rd, sing., agreeing with 'step.'
that—rel. pro., 3rd, sing., com., nom. to 'crawls.'
crawls—verb, reg. intrans., act., ind., pres., 3rd, sing. agreeing with 'that.'
evening—noun, abs., neut., sing., 3rd, obj., gov. by 'at.'
he—pro., pers., masc., sing., 3rd, nom. to 'will tread.'
that—pro., rel., masc., sing., 3rd, nom. to 'has.'
humanity—abs. noun, neut., sing., 3rd, obj., gov. by 'has.'
forewarned—part. adj. of quality, qual. 'he.
will—aux. verb to 'tread,' indg. future tense
tread—verb, irreg. intrans., act., inf., pres., gov. by 'will.'
will tread—verb, irreg. intrans., act., ind., fut., 3rd, sing., agreeing with 'he.'
aside—adv. of manner, qualg. 'will tread.'
let—verb, irreg. trans., act., inf., gov. by 'will.'
live—verb, reg. intrans, verb, act., inf., gov. by 'will let.'

2. Explain how the word 'aside' is formed, and give instances of adverbs of similar formation.

Aside is formed from the prefix *a*, which means *in* or *on*, and the noun *side*. *A* having the force of a preposition, the word may be said to be formed of a preposition and a noun.
Other adverbs:—abed, afoot, ashore.

3. Point out a Latin prefix and a Latin suffix in the above.

Prefix: *in* in *inadvertent*.
Affix: *ent* in the same word.

4. Correct, if needful, the following sentences:—

(*a*) It is I that he fears.
(*b*) He is a boy of nine years old.
(*c*) Who can this letter be from?
(*d*) I feel coldly this morning.

(*a*) It is I whom he fears.
(*b*) He is a boy nine years old.
(*c*) Whom can this letter be from?
(*d*) I feel cold this morning.

Geography.

1. Draw a full map of Egypt, showing the position of the Soudan and of the places connected with the present war.
N.B.—Insert the lines of latitude and longitude.

2. Gives notes of a Lesson on 'China, its physical character, chief towns and rivers, and the character of the people.'

Physical character.—1600 miles long, 1300 miles broad. Consists of a series of large river basins opening out to a long flat coast in the east, but the watersheds are mountainous in the west. Chief ranges Pe-ling, Nan-ling, Sin-ling, Yun-ling, in China proper; Thian-Shan, Tangua Oola separating it from Siberia, and the Himalaya from India; Kling Khan in Mongolia; In-shan in the centre. Between the Himalayas and the Thian-Shan lies the sandy, rainless desert of Gobi, extending 1000 miles from east to west.

Rivers.—Amoor in the N., partially in Siberia: Hoang-ho and Yang-tse-kiang, rising near each other and flowing eastward, the Canton river, and the Peiho river. Volume of water great, carries down great quantities of mud, (hence *Yellow* river and sea.) Describe 'bore' caused by water meeting tide.

Chief towns.—China very populous; hence towns large with narrow streets, crowded houses and streets.

Pekin, on Peiho, capital, walled, fortified, end of great canal, 770 miles long; *Nankin*, formerly capital, nearly a million people, ruins, pagodas, temples; *Canton*, or Se-kiang, 800,000 people, first port, great river population; *Amoy*, *Foochew*, *Ning-po*, *Shang-hai*, are ports, *Tien-Tsin* on canal.

People.—Very industrious, possessing much manufacturing skill and ingenuity, performing with ease delicate work of different kinds; fond of their country, to which they return if possible, after having made money elsewhere. Averse to mixing with strangers, who were excluded from the country till recently. Disciples of Confucius, a deist, or worshippers of Fo, probably the same as Hindoo Buddha.

3. What are Monsoons? Where are they felt? And what are their effects?

Monsoons are trade winds, modified by the climates of the countries over which they pass. They are felt along the east coast of Africa, but more especially in India. They blow from N.E. from November to March, and from S.W. from April to October. When once established, the S.W. Monsoon coming across the Indian Ocean is charged with moisture, which falls in great showers of rain on the W. Ghauts. The west of India has thus periodical rains as one result of the monsoons. The N.E. Monsoon in a similar manner, carries rain to the coast of Africa. At the time of the change of monsoons, great quantities of rain, attended by storms of thunder, are precipitated.

Monsoons, not so decided as those of the Indian Ocean, are common between Australia and China, and on the Coasts of Mexico and Brazil.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination papers.

Arithmetic.

MALES.

1. If I buy railway stock, paying a dividend of 6½ per cent., at 129⅞, what rate per cent. do I get for my money, the usual brokerage being charged?

I receive £6½ for £(129⅞ + ¼).
∴ Rate of interest = As 130 : 100 :: 6½ : £5. Ans.

2. What principal will amount to £594·88 at compound interest in 2 years at 4 per cent. per annum?

4 p. c. = 1/25 | 100
4
4 p. c. = 1/25 | 104 End of 1st year.
4·16
108·10 End of 2nd year.

£ £ £ £
∴ 108·16 : 594·88 :: 100 : 550. Ans.

3. State the rule for pointing in square root. Find to three places of decimals the square roots of 168·1, ·2, and 01.

Place a point over the units figure, and then over every second figure to the left, and also to the right when there are decimals.

If a period is not complete in the decimal fraction, add a 0 to complete it.

168·160000(12·965. Ans.
1
22) 68
44
249) 2410
2241
2586) 16900
15516
25925) 138400
129625
8775

·200000(·447. Ans.
16
84) 400
336
887) 6400
6209
191

·01111(·105. Ans.
1
205) 1111
1025
86

4. If a grocer by selling tea at 2s. 6d. per lb. gains 12 per cent., what did it cost him per cwt.?

Selling price = 2s. 6d. × 112 = £14
" " = cost price + gain
= 100 + 12
= 112 per cent.

£ £ £ £ s.
∴ 112 : 100 :: 14 : 12 10

History.

MALES AND FEMALES.

1. Trace the descent of Queen Victoria from James I.

James I.
|
Elizabeth mar. Fredk. of Bohemia.
|
Sophia, mar. Elector of Hanover.
|
George I.
|
George II.
|
George III.
|
Edward, Duke of Kent.
|
Victoria.

2. Who was Queen Anne? Mention persons illustrious in war and in literature during her reign.

Queen Anne was the younger daughter of James II. She succeeded to the throne of England on the death of her brother-in-law, William III., in 1702.

War.—Duke of Marlborough, Prince Eugene, Sir George Rooke.

Literature.—John Locke, Sir Isaac Newton, Alexander Pope, Joseph Addison, Sir Richard Steele, Daniel De Foe, Dean Swift.

3. How do you account for the success of the American colonists in the War of Independence?

The colonists were fighting for the independence which they had enjoyed since leaving this country. They were roused as a whole nation to the conflict. They were cheered by success at the first. They were led by men of superior ability, in whom they placed every confidence, while, in some instances, the British forces were led by men much less fit for their work. They had everything to gain, and much to lose in the conflict, and inspired by help from France, and the lukewarmness of many of the English, there was little wonder that they were successful.

Teaching.

Write the notes of a lesson to a Sixth Standard on 'Latin Prefixes.'

Formation of Words.—Recapitulate results of previous lessons in Standard V. on 'Word Building.' Show how compound words were made of two simple words, and that gradually one part of the word changed in form, and sometimes in meaning, *e.g.*, be-cause for by-cause, a-foot for on-foot.

Prefixes.—When these words have lost their original form, or when they are put before other words, we call them *prefixes*. The meaning of many is arrived at by comparing many words. Numbers of prefixes, and especially in Latin, are only the Latin prepositions put to roots of verbs or nouns.

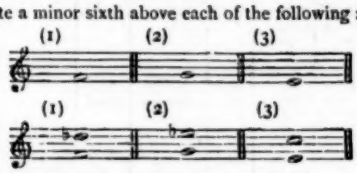
Use of Prefixes.—For forming words from roots. Words so formed called *Derivatives*. Give examples, and show how some of the prefixes take different forms to adapt themselves to the roots to which they are prefixed, *e.g.*, *con* becomes co, cog, col, com; *e* has the form of ex, ef. Compare the same prefix in different words, and show that the meaning varies with the use of words. Recapitulate, and ask for division of words into roots and prefixes to show that the lesson has been understood.

Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write a minor sixth above each of the following:—



2. Re-write the following, doubling the value of every note and rest:—

3. State briefly the meanings of the following terms:—(1) *Da Capo*; (2) *Dal Segno*; (3) *Vivace.*

3. (1) Repeat from the beginning; (2) repeat from the sign; (3) lively, sprightly.

TONIC SOL-FA NOTATION.

1. Write minor sixths above the following:—(1) *me*; (2) *lah*; (3) *te.*

1. (1) *doh*^{1}; (2) *fah*^{1}; (3) *soh*^{1}.

2. What are the five kinds of measure commonly used?

2. Two-pulse; three-pulse; four-pulse; six-pulse; nine-pulse.

3. Explain the following terms:—(1) *Da Capo*; (2) *Dal Segno*; (3) *Vivace.*

3. (1) Repeat from the beginning; (2) repeat from the sign; (3) lively, sprightly.

FOURTH YEAR.

Pupil Teachers at end of Fourth Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 3, if you can do so.

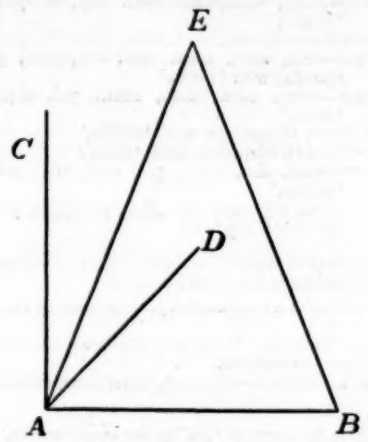
1. If a straight line be divided into two equal parts, and also into two unequal parts; the rectangle contained by the unequal parts, together with the square on the line between the points of section, is equal to the square on half the line.

Euclid, Bk. II., Prop. 5.

2. In obtuse-angled triangles, if a perpendicular be drawn from either of the acute angles to the opposite side produced, the square on the side subtending the obtuse angle, is greater than the squares on the sides containing the obtuse angle, by twice the rectangle contained by the side upon which, when produced, the perpendicular falls, and the straight line intercepted without the triangle between the perpendicular and the obtuse angle.

Euclid, Bk. II., Prop. 12.

3. Construct a triangle having each of the angles at the base one and a half times the vertical angle.



At point A in straight line AB erect perpendicular AC. Bisect ∠ BAC by straight line DA (I. 9). Bisect ∠ DAC by straight line AE (I. 9). At point B make ∠ ABE = ∠ BAD. Produce BE and AE to meet in E. BAE is the triangle required.

∵ BAC is a right ∠, and DA bisects it, ∠ BAD is half a right ∠, and ∵ ∠ DAC, which is half a right ∠, is bisected by EA, ∠ DAE is ¼th of right ∠. ∴ ∠ BAE is ¾ths of a right ∠; and (Const.) ∠ ABE is also ¾ths of a right ∠.

And since three ∠'s of a △ = two right ∠'s, ∠ AEB is half a right ∠.

∴ Each of the ∠'s at the base is one and a half times the ∠ at the vertex. Q. E. F.

Algebra.

Answer two Questions, including the first Question, if you can.

1. *Prove* the rule for multiplying and for dividing a fraction by an integer.

Multiply together $\frac{1-a^2}{b+b^2}$, $\frac{1-b^2}{a+a^2}$, and $b+\frac{ab}{1-a}$

Proof for multiplication:

When the numr. is multiplied. Let $\frac{x}{y}$ denote any frac. and z any integer: then $\frac{x}{y}\times z=\frac{xz}{y}$. For in each of the fracs. $\frac{x}{y}$ and $\frac{xz}{y}$, the unit is divided into y parts and z times as many parts are taken in $\frac{xz}{y}$ as in $\frac{x}{y}$: hence $\frac{xz}{y}$ is z times $\frac{x}{y}$.

When the denr. is divided. Let $\frac{x}{yz}$ be any frac. and z any integer. Then $\frac{x}{yz}\times z=\frac{x}{y}$. For in each frac. $\frac{x}{yz}$ and $\frac{x}{y}$, the numr. is the same, but each part in $\frac{x}{y}$ is z times as large as in $\frac{x}{yz}$ because in $\frac{x}{yz}$ the unit is divided into z times as many parts as in $\frac{x}{y}$, hence $\frac{x}{y}$ is z times as great as $\frac{x}{yz}$.

$$\frac{1-a^2}{b+b^2}\times\frac{1-b^2}{a+a^2}\times b+\frac{ab}{1-a}$$
$$=\frac{(1-a)(1+a)}{b(1+b)}\times\frac{(1-b)(1+b)}{a(1+a)}\times\frac{b}{1-a}$$
$$=\underline{\frac{1-b}{a}}\cdot \text{ Ans.}$$

2. Find the relation between a, b, c, in order that ax^2+bx+c may be a perfect sq.

Extract the square root of—

$$x^4-4x^3+10x^2-12x+9.$$

Extract the sq. root of ax^2+bx+c, and equate the remainder to zero; thus,

$$\begin{array}{r|l} ax^2+bx+c & \left(x\sqrt{a}+\frac{b}{2\sqrt{a}}\right. \\ \underline{ax^2} & \\ 2x\sqrt{a}+\frac{b}{2\sqrt{a}}\Big)bx+c & \\ \underline{bx+\frac{b^2}{4a}} & \\ c-\frac{b^2}{4a} & \end{array}$$

The relation is therefore, that

$$c-\frac{b^2}{4a}=0, \text{ or that } \underline{b^2=4ac}.$$

$$\begin{array}{r|l} x^4-4x^3+10x^2-12x+9 & (x^2-2x+3 \\ \underline{x^4} & \\ 2x^2-2x) \quad -4x^3+10x^2 & \\ \underline{-4x^3+4x^2} & \\ 2x^2-2x+3) \quad 6x^2-12x+9 & \\ \underline{6x^2-12x+9} & \end{array}$$

3. Solve the equations—

(1) $111x-\frac{y}{111}=2=\frac{y}{37}-37x.$

(2) $x-a+\frac{5}{x-a}=6.$

(1) $111x-\frac{y}{111}=2$ (I.)

$-37x+\frac{y}{37}=2$ II.

Mult. II. by 3

$111x-\frac{y}{111}=2$

$-111x+\frac{3y}{111}=6$

$\frac{8y}{111}=8$

$8y=888$

$y=\underline{111}.$ Ans.

Substitute value of y in I.

$111x-\frac{111}{111}=2$

$111x-1=2$

$111x=3$

$x=\underline{\frac{1}{37}}.$ Ans.

(2) $x-a+\frac{5}{x-a}=6$

$(x-a)^2+5=6(x-a)$

$(x-a)^2-6(x-a)=-5$

$(x-a)^2-6(x-a)+3^2=9-5$

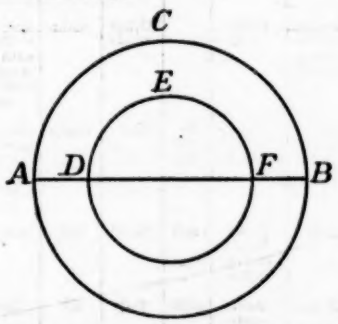
$x-a-3=\pm 2$

$x=\underline{5+a}.$ Ans.

Or, $x=\underline{a+1}.$ Ans.

Mensuration.

Show that the area of a circular ring may be (approximately found by multiplying together the sum and difference of the inner and outer diameters and $\frac{11}{14}$.



Let ACB and DEF be two circles, DEF being the less, having diameters of 6 and 4 respectively.

Then the area of ring = area of large − area of less circle.

Area of large circle $= 6^2 \times \cdot 7854 = 28\cdot2744$

" small " $= 4^2 \times \cdot 7854 = 12\cdot5664$

" ring $= 15\cdot7080$

$(6+4) \times (6-4) \times \frac{11}{14} = \frac{220}{14} = 15\frac{10}{7} = 15\cdot7142$. Ans.

Arithmetic.

FEMALES.

1. Divide £22 9s. 2d. among 3 persons so that one has twice as much as the second, and three times as much as the third.

Their shares will be in the ratio of 6, 3, 2,

Total shares, 11.

	£ s. d.	£ s. d.
The first will get $\frac{6}{11}$ of 22 9 2	= 12 5 0	
" second " $\frac{3}{11}$ "	= 6 2 6	} Ans.
" third " $\frac{2}{11}$ "	= 4 1 8	

2. Find the cost of carpeting a room 18 ft. 9 in. long and 17 ft. 6 in. broad, with carpet 2 ft. wide at 4s. 9d. a yard.

$$\text{No. of yds. reqd.} = \frac{18\frac{3}{4} \times 17\frac{1}{2}}{2 \times 3}$$

$$\text{and the cost} = \frac{18\frac{3}{4} \times 17\frac{1}{2} \times 4\frac{3}{4}}{2 \times 3}$$

$$= \frac{75}{4} \times \frac{35}{2} \times \frac{19}{4} \times \frac{1}{2} \times \frac{1}{3}$$

$$= \frac{49875}{64}$$

$$= £12\ 19s.\ 9\frac{3}{16}d.$$ Ans.

3. A merchant buys a 50 gallon cask of wine for £62 10s. and sells it at 26s. per gallon; what is his total gain and gain per cent.?

	£	s.
Selling price = 26s. × 50 =	65	0
Cost price =	62	10
Total gain =	2	10. Ans.

£ s. £ £ s. £

∴ 62 10 : 100 :: 2 10 : 4 Gain per cent.

4. A person wishes to make an income of £100 per annum by investing £2666 13s. 4d. in the 3 per cent. Consols; find what price they must be quoted at when he buys in.

£ £

100 is produced by $2666\frac{2}{3}$

1 " " $\frac{2666\frac{2}{3}}{100}$

3 " " $\frac{2666\frac{2}{3} \times 3}{100} = £80$; the price. Ans.

Grammar.

MALES AND FEMALES.

1.

Mighty *winds*,
That sweep the skirt of some *far-spreading* wood
Of ancient *growth*, *make music not unlike*
The *dash* of ocean on its winding shore,
And *lull* the spirit while they fill the mind.

Analyse the above, parsing the words in italics.

ANALYSIS.

Sentence.	Kind of Sentence.	Connective.	Subject.	Predicate.	Object.	Extension.
(a) Mighty winds make music not unlike the dash of ocean on his winding shore	Princ. sent.		Mighty winds	make	music not unlike the dash of ocean on his winding shore	
(b) that sweep the skirt of some far-spreading wood of ancient growth	Adj. sent. to *winds* in *a*	*In rel.* pro.	that	sweep	the skirt of some far-spreading wood of ancient growth	
(c) and lull the spirit	Princ. sent. co-ord. with *a*	and	[they]	lull	the spirit	
(d) while they fill the mind	Adv. sent. (time) to *a* and *c*	while	they	fill	the mind	

PARSING.

Winds—noun, com., neut., plur., 3rd, nom. to 'make.'
that—pro., rel., neut., plur., 3rd, nom. to 'sweep.'
far-spreading—compound part. adj., of quality, qual. 'wood.'
growth—noun, abs., neut., sing., 3rd, obj., gov. by 'of.'
make—verb, irreg. trans., act., ind., pres., 3rd, plur., agreeing with 'winds.'
music—noun, com., sing., neut., 3rd, obj., gov. by 'make.'
not—adv. of negation. qual. 'unlike,'
unlike—adj. of quality, qual. 'music.'
dash—noun, abs., neut., 3rd, sing., obj, gov. by adj. 'unlike.'
lull—verb, reg. trans., act., ind., pres., 3rd, plur., agreeing with 'they' und.

2. What sort of word is 'far-spreading'? Give examples of *other* combinations in compound adjectives.

Far-spreading is a compound adjective, made up of a participle and an adverb.

Other combinations: Noun and Adjective—snow-white, wilful, brand-new, stone-blind.

Verb and Adverb:—well-bred, under-done, over-done, high-born.

3. What is the force of 'un' in the word 'unlike,' and what other meaning has it when prefixed to a verb? Give examples.

Un in *unlike* means not. It also means *back*, as untie, unlock, undo, unroll, unfold, unbar.

4. Mention some of the principal events that have contributed to bring our language into its present form.

English is a Teutonic language, brought over by the Saxons from Germany at the invasion in the 4th century. It is, however, very largely mixed up with words which have a different origin, these words having been introduced in the following ways:—Some words were adopted from the ancient inhabitants of this country. These are Keltic. A few Latin words from the Romans are found in the language; the bringing of Christianity by missionaries introduced many more connected with the Church. When the Normans invaded England they brought still more Latin words, slightly changed in form by coming through the French. The revival of learning in the 15th century added more still. The great amount of commerce England has, her connection with every nation in the world, and the importance of the country generally, have added words from nearly every known language. In this way we have Spanish, Italian, Portuguese, Turkish, Hindu, Persian, Malay, American, and other words in the language, making English the most composite of known languages.

Geography.

(*Answer two Questions including Q.* 1.)

1. Draw a full map of Australia, including Tasmania. Insert lines of latitude and longitude.

2. Give notes of a lesson on 'Day and Night.' Illustrate by diagrams.

Introduction.—Draw attention to parts of day, eliciting names, morning, forenoon, noon, afternoon, evening, midnight, dawn, and twilight. Also that light is derived from sun.

Cause of Day and Night.—Show that phenomena might be caused in *two* ways—(*a*) by earth turning round on its axis; or, (2) by sun going round the earth. Latter formerly believed. Hence common expressions, *sunrise* and *sunset*, *sun going from east to west*, etc. Former the real cause. Illustrate by candle and globe, or by sun shining through window on globe. From same illustration show the way in which dawn, sunrise, sunset, and twilight are caused.

Day and night at different times in different places.—Morning at all places on same meridian at same time. (Show how). There being 360° round the earth, and a rotation of the earth taking place every 24 hours, time is one hour later for every 15°.

Show globe or map, and give exercises and examples.

Benefits of day and night.—Time of rest, provision for radiation, cooling of earth, formation of dew necessary to the earth's vegetation.

3. 'All the long and gentle slopes descend towards the Atlantic Ocean; all the short and rapid slopes towards the Pacific, and its continuation, the Indian.'

Show from each continent, as fully as you can, that this statement is true.

In America the Rocky Mountains and their continuation, the Andes, are within a comparatively short distance from the Pacific; and all the great rivers, Mississippi, St. Lawrence, Amazon, Orinoco, La Plata, etc., flow to the Atlantic. No large rivers flow into the Pacific.

In Europe the rivers are all drained into the Atlantic Ocean and its seas, and the axis of the mountain chains is much nearer the southern part of the Continent than the northern.

In Africa the high lands are near the coast, but the mountains of southern Soudan are much nearer the Indian than the Atlantic Ocean, thus leaving the longest slope towards the Atlantic.

In Asia the mountain chains run from N.E. to S.W., the ranges beginning near the Pacific and keeping near that ocean and the Indian throughout their entire length. The southern slope of the Himalayas is abrupt and rugged, but long and gentle to the north till it reaches the Arctic Ocean.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination papers.

Arithmetic.

MALES.

1. If a cubic foot of water weighs 62·5 lbs., and half a pint weighs 10 oz., find the number of cubic inches in a gallon.

One gallon = 16 half-pints;

Then weight of one gall. = 16 × 10 = 160 ozs.

62·5 lbs. = 1000 ozs.

oz. oz. cub. in. cub. in.

∴ 1000 : 160 :: 1728 : 276·48. Ans.

2. A man wishes to divide £11,400 amongst his two sons and daughter in such a way that the eldest son may get half as much again as the second, and the second son half as much again as the daughter. Find their shares.

Their shares will be in the proportion of 1, 1½, and 2¼, or 4, 6, and 9. Total shares 19.

The eldest son will get $\frac{9}{19}$ of £11400 = £5400. Ans.

The second son ,, $\frac{6}{19}$,, = £3600. Ans.

The daughter ,, $\frac{4}{19}$,, = £2400. Ans.

3. A man invests money in the 3 per cents. at 97⅛, and after a year sells out at 101¼, and the interest and profit on the sale amount to £145. How much money did he invest, brokerage being charged on each transaction?

The buying price of Stock was 97⅛ + ⅛ = 97¼.

,, selling ,, ,, ,, 101¼ − ⅛ = 101⅛.

The gain on each £97¼ spent was 101⅛ − 97¼ = 4⅛.

The interest + gain = 4⅛ + 3 = 7⅛.

No. of £97¼'s spent was $\frac{145}{7\frac{1}{8}} = 20$.

Amount invested = 97¼ × 20 = £1950. Ans.

4. A, who walks 4½ miles an hour, and B who walks 4⅛, start together to walk round a ring 6 miles in circumference; find when they will be together next, and at what distance from the starting-point.

B gains on A (4½ − 4⅛) = ⅜ m. per hour.

As the course is 6 m. round, he will overtake him in

6 ÷ ⅜ hr. = 16 hours.

In 16 hrs. A travels 4½ × 16 = 68 miles.

,, ,, B ,, 4⅛ × 16 = 74 ,,

68 miles is 11 times the course + 2 m.

74 ,, 12 ,, ,, + 2 m.

They would therefore be 2 m. from the starting-point.

16 hours; 2 miles. Ans.

History.

MALES AND FEMALES.

1. 'No living Englishman can say with certainty that the blood of Celt and Gaul, Welshman and Irishman, Frisian and Flamand, French, Huguenot, and German Palatine does not mingle in his veins.' Explain the statement.

The ancient inhabitants of this country were Celts, and in 1066 there was an invasion from Gaul, the Normans remaining in the country. Welshmen and Irishmen have settled in this country at all times since the conquest of these countries in the 12th century. Frisians were among the invaders and settlers in the 4th and later centuries. Flamands came in the time of the Conqueror, and made a descent on Suffolk in the time of Henry II., and were encouraged to settle by Edward III. The French Huguenots, to the number of 50,000, settled in England after the revocation of the edict of Nantes, while of Germans the main body of English may be said to be composed. Having all settled and intermarried in the course of many centuries a general mixture of the races has taken place.

2. What is meant by a convention parliament? Give particulars of any such parliaments.

A convention parliament is one which is summoned for a specific purpose, without having been called by the king.

After the dissolution of the Long Parliament by its own act in 1660 a new parliament met for the purpose of recalling Charles II.

In 1688, after the flight of James II., a convention parliament met for the purpose of offering the Crown to William Prince of Orange.

A third convention parliament met in 1788 during the insanity of George III., for the purpose of deciding upon a Regency while the king was unfit to perform the duties of his office.

3. What causes produced the Irish rebellion of 1798?

During the latter part of the eighteenth century, attempts were made to do away with the legislative independence of Ireland, and in the sixth year of George I. the Irish House of Lords was deprived of its appellate jurisdiction, and the Act also declared that the English Parliament had the right to make laws to bind the Irish people. The Irish Parliament was filled with persons in the pay of England. A rebellious spirit now arose in the country. The *Freeman's Journal* was established. Attacks were made on the English Government. Secret societies were formed in large numbers, and sedition was rife. Grattan wished and worked for legislative independence, and when the American war broke out (1774) his opportunity arrived. The volunteers formed a Convention to assist him, and the result was the repeal of the Act of the sixth year of George I. Then differences arose between the leaders. Some, the more embittered against England, were not satisfied, and these, roused by the success of the French revolution, determined to fight for freedom. Their chief leaders were Tone, Fitzgerald, and O'Connor. The former obtained the assistance of a French fleet, which was, however, destroyed by bad weather. The Government became alarmed, sent soldiers over to Ireland in large numbers, who were lodged in different parts of the country, and committed great excesses. The people then rose in rebellion.

Teaching.

Write out notes of a lesson on 'WATER AND ITS FORMS.'

Apparatus needed.—If possible have water, a test tube, spirit lamp, and piece of ice.

I. *Water as a liquid.*—Draw attention to water as commonly seen as a *liquid*, and show that (*a*) its particles move freely about; (*b*) that it is nearly incompressible; (*c*) that it presses equally on all sides; (*d*) and that it finds its level.

Call attention to fact of its wide diffusion, ocean, seas, rivers, lakes.

II. *Water as a gas.*—Pour a little water on a slate, place over spirit lamp. Observations made—(*a*) heat turns water into *steam*; (*b*) steam invisible; (*c*) when partially *condensed* called *vapour*; (*d*) heat expands water (seen in test tube).

Effect of sun on surface of earth similar. Roads dry up; vast quantities of vapour raised from sea form clouds. Condensation by coming in contact with cold. Examples: breath on slate, vapour in a room, clouds, fog, mist, dew.

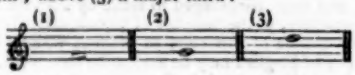
III. *Water as a solid.*—Show ice, expose to heat turn to water. From experiment derive—(*a*) water exists as a solid as ice; other forms, snow and hail; (*b*) that it is converted into liquid by heat; (*c*) that ice when melted occupies less space when liquid than when solid.

Music.

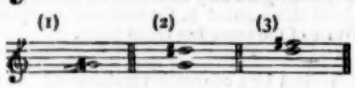
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write above (1) an augmented second; above (2) an augmented fifth; above (3) a major third:—



1.



2. Write the ascending scale of E minor, using the minor sixth and the sharp seventh, placing the necessary sharps before the notes:—

2.

3. Complete each of the following by adding the necessary rest or rests:—

3.

TONIC SOL-FA NOTATION.

1. Write above (1) *fah* an augmented second; above (2) *soh* an augmented fifth; above (3) *ray* a major third.

1. (1) *se*; (2) *re'*; (3) *fe*.

2. In the minor mode (*a*) what is the essential sixth; and (*b*) what is the essential seventh;

2. (*a*) *fah*; (*b*) *se*.

3. Re-write the following, doubling the value of every note and rest.

3. |n :-.s |f. :n. ‖

3. |n :— |— :s |f : |n : ‖

Friedrich Fröbel.

BY HIS PUPIL, HEINRICH HOFFMAN.

X.—(*continued.*)

BUT great as were their difficulties, neither Fröbel nor his friends despaired of ultimate success. In 1828 Fröbel wrote to Barop:—

'Our outer life is still in its undeveloped state, and still shrouded in dark, stormy night, the black clouds of which may at any time send forth their disastrous flash of lightning. However, so far, God, with His mighty arm, has ever held His protecting shield over us, and like chickens in a storm beneath the sheltering wings of their mother, so we have been permitted, amidst the terrors of the tempest, to rest in the lap of the faithfully tender mother. . . . Never mind what they say about us in Berlin; continue to act faithfully to your conviction. As to myself, everything becomes clearer. That which formerly was founded in my belief, in my conviction, and but partially in my own intuition, I now see in all creation, in the development of things, in nature, in Divine dispensation, and in the course of culture in mankind; God in creation, in nature, and in the order of the universe, in the culture of mankind. God the original idea of man's education—this is the foundation stone of my inner and outer life! On this foundation you may maintain the rights of nature with more than Lutheran rock-like firmness, and thus act as a champion for our educational scheme.'

What a very checkered, motley life was Fröbel's! What ups and downs; what sudden changes between brilliant flashes of light and utter darkness! And what is the meaning of the grand rising of that luminous star yonder? Will it at last lead the storm-beaten mariners to a safe port? Yes, so it seems. The Duke of Meiningen had his attention drawn to the wonderful doings at Keilhau; had desired Fröbel to initiate him in his educational schemes; had held frequent interviews with him, and proposed to found a national school on an extensive scale, where Fröbel could carry out his plans unfettered and quite in his own way. The preliminaries were agreed upon. Fröbel was to have the large estate of Helba, with all the extensive grounds belonging thereto, and an annual subsidiary grant of one thousand florins.

What a festival of joy at Keilhau when thus the long-hoped-for harbour came in sight! Fröbel was all excitement, all animation, all eagerness, to draw up the plans; and never was any scheme more exactly and carefully elaborated, even to the minutest detail. With restless energy he worked at it for several months, and we can imagine his delight as he thought of the bright vision before him!

Mere teaching could not satisfy Fröbel. Practical exercises in wood, in paper, in pasteboard, in garden and field, were to supplement and elucidate the oral lessons; practical work was to stimulate theoretical inquiry; on it theory was to rely for confirmation. Man was to be educated not merely as a receptive being but as an active and producing one. Work, instruction, and play were to form one undivided whole. Rapidly his plans expanded to stupendous dimensions. Not only would he have an educational institution for boys, but also a home for motherless children and orphans from three to seven years of age, a college of German art and industry, whilst Keilhau was to be raised to a high school where young men could be prepared for the University.

'All in vain,' seems to be the natural sigh of our disappointed minds when we learn how the jealousy of narrow-minded ministers had been at the mean work of poisoning the Duke's mind against Fröbel. Although the agreement was signed, and the institution publicly advertised, Fröbel withdrew at once when he detected a lurking distrust.

No, 'All in vain' would be a short-sighted verdict; to call the whole affair a will-o'-the-wisp would not be quite correct, inasmuch as with the assiduous and careful working out of the plans, a great and decisive step had been taken towards the crowning of his life's labours.

To us, who can survey at one glance, cause, facts, and results of a bygone period, it matters but little that such ardent hopes and expectations were again doomed to disappointment. Keilhau was now too narrow for him; he had tried his wings, and found them strong enough for a higher flight. Besides, with so small a number of pupils, it was impossible to keep up an establishment of three or four families. So Fröbel proceeded to Frankfort to consult his dear friends. Frau von Holzhausen proved once more his faithful genius. She introduced him to Herr Schnyder von Wartensee, a musical composer of great renown, a pupil of Beethoven, and, at one time, the music master at Pesta-

lozzi's establishment at Yverdun. This gentleman was quite fascinated with Fröbel's educational views, and being possessed of considerable means, he liberally offered him his chateau, 'Wartensee,' on lake Sempach, in Switzerland, for the realization of his plans. On the 12th of August, 1831, an official document was delivered to Herr Schnyder, which deserves to be recorded:—

'The Educational Council of the Canton of Luzern to
'Herr Xaver Schnyder von Wartensee.

'Most Esteemed Sir,—We take great pleasure in communicating to you and to Herr Friedrich Fröbel the decree of the Committee, by which your plan to establish a private school at Wartensee, has been approved of, and legal permission thereof granted.

'We congratulate our canton on the acquisition of a school which, under such intelligent leaders, cannot fail to exercise the most beneficial influence on all our scholastic institutions, and have the honour to offer you our special protection, and to assure you of our hearty co-operation, on which you may always rely in anything that can further the prosperity of so philanthropic, and so noble an undertaking.

'Accept, sir,' etc.

Such a welcome must have been encouraging indeed! With a noble generosity not often met with, Schnyder placed at Fröbel's service a fine mansion, furnished, not only completely, but in a style almost princely, with even a rich store of plate. Really, the key to his Eldorado seemed to be in his hands at last! His nephew, Ferdinand Fröbel, son of his brother Christian, joined him in this promising work.

No sooner had the new undertaking been advertised in the public papers than a most infamous libel appeared in the *Appenzeller Zeitung*, October 1, 1831, in which scurrilous calumnies and lies were shamefully hurled against Fröbel's character and his institution in Keilhau. Fröbel declared that he considered it unworthy of him to reply to an anonymous article, but since his life and all his doings were open to all the world, he requested that the writer should come forth publicly, should re-issue his charges in the *Rudolstädter Wochenblatt*, as well as in the *National Zeitung der Deutschen*, in Gotha; and, moreover, send a copy of it to the Government in Rudolstadt. Then only would he engage to clear himself of the frivolous charges.

In the same month several articles appeared in the *Aargauer Zeitung*, eulogising Fröbel and Schnyder, and speaking in high terms of Keilhau.

That the wanton attack had completely failed to set the Wartensee public against the undertaking, was soon manifested in a most satisfactory manner by the large number of day-pupils. Sempach and other neighbouring villages also sent a considerable number, but the expected influx of boarders failed; and a serious disappointment this proved to be, inasmuch as the financial exigencies had to be met principally from that source. How far this failure may be attributed to the scandalous article referred to above, or to the secret undermining of hostile priests, will probably never be ascertained.

It is touching to see how faithfully the Keilhau friends stood by their leader. Scanty as were their resources, and all but overwhelming their own anxieties, they still managed to send welcome support; but when in the second year matters did not appear to improve, Barop was commissioned to investigate thoroughly the state of things at Wartensee. Under great personal privations, and as a poor pedlar, he managed to accomplish the long journey on foot. He found the public greatly in favour of the school; the only objection they had to Fröbel and his associates was that they were 'heretics.' The buildings, designed for a palatial residence, were not at all suitable nor efficient in accommodation for a large school, nor was the slightest alteration permitted; so, after careful deliberation, they found that, in the face of the secret sinister influences at work, the school could not hold its own and had better be removed, but whither they knew not.

They still had confidence in the guidance of Him whose work they believed they were accomplishing, and disappointments are, and ever will be among His best and most effectual means of education.

One evening they sat at the village inn, so much absorbed in earnest deliberation that they failed to notice the deep interest with which their conversation was listened to by three strangers, who subsequently introduced themselves as commercial men from Willisau, Canton Luzern, and, with great animation, besought Fröbel to transfer his school to their town. They promised him every assistance; and in a short time a formal application was received, signed by twenty of the leading families, already formed into an association for the promotion of Fröbel's educational schemes.

Fröbel readily consented; the committee procured the grant of the large Government house, and so far the way was made plain. During the interval previous to the opening he visited Keilhau, and also his mother-in-law at Berlin (February, 1833). A most valuable acquisition to the staff of teachers was made in Adolph Frankenberg, who had just finished his theological studies in Göttingen, but on account of the dissolution of the University under King Ernest George was obliged to forego his examination. He joined the friends with heart and soul, proved to be admirably adapted to his position, and henceforth devoted his life to the sacred cause with earnest and indefatigable faithfulness.

Meanwhile the Roman Catholic clergy had left no stone unturned to crush the new project. They had used all their influence in Government circles against Fröbel, and it was not before March that Barop could inform him of final victory. In April the official documents arrived, and Fröbel and his wife repaired to their new destination. The school was opened with thirty-six pupils. The hearty co-operation and the high esteem of the educated classes certainly never flagged; but, bad as the fanatical intolerance of the priests had been at Wartensee, it proved infinitely worse in Willisau. Not only did they prevent boarders from coming, but they excited the mob against them in a most unscrupulous manner. Fröbel and his friends were repeatedly cautioned by kindhearted people not to take their regular walks in the same direction, as their lives were in danger.

They never failed to attend public worship, and did everything they could to make the people forget that they were of a different creed.

Once they assisted at some church festival by conducting the musical part, when, as a singular recognition of their services, a most vehement philippic was hurled against them from the pulpit, and the frightened congregation was exhorted to secure to themselves an everlasting treasure in heaven.

(To be continued.)

Publications Reviewed.

Life, Function, Health. Studies for Young Men. By H. Sinclair Paterson, M.D. London: Hodder and Stoughton.

This is a volume of lectures by a talented writer, on various biological and physiological matters. It really consists of three portions, each containing eight lectures, which were separately published after their delivery before the Young Men's Christian Association.

The first part contains 'Studies in Life'; and discusses the characteristics, origin, varieties, natural history, enemies, and results of life. The author shows throughout a strong religious bias, with which we thoroughly sympathise; but nowhere does he allow this to prevent his clear description of scientific theories, or lead him into rancorous opposition to the theories of those scientific leaders who hold different views from his own. On the contrary, a liberal spirit and a knowledge thoroughly conversant with scientific matters is constantly manifested.

The chapter on the 'Enemies of Life' is particularly interesting from a sanitary standpoint.

The second part discusses 'The Human Body and its Functions.' It is really a popular description of the broad facts and principles of physiology, stated in a thoroughly untechnical and lucid manner, which will be interesting to all. The descriptions of the Commissariat and Intelligence Departments, and what we may venture to name the Sewage Department, are all simple and instructive; while the chapter on the Executive Department, in which the evolution of energy in the body is discussed, ought to be read by all.

The third part consists of 'Health Studies,' and may be regarded as an application of the principles stated in the previous sections to the maintenance of health. Food and appetite, exercise, worry, rest, and sleep are carefully discussed, and many valuable health lessons may be gathered from these chapters. The chapter on 'Fastness' deals carefully and delicately with an important subject, and one on which young men sadly lack advice; while, under the head of 'A Merry Heart,' the influence of mind on body is discussed.

The chapter on 'Disease Germs' contains much useful information, though the division of zymotic diseases into epidemic, endemic, and infectious is by no means logical.

The last chapter on the 'Rational Principles of Medicine' tells us what *not* to expect from doctors, and no one would be gladder than medical men, if the common notion of *specifics*—that, in other words, for every disease there is a remedy, which only needs to be employed after a rule-of-thumb fashion—were completely smashed. Such a notion is derogatory to the true honour of the medical profession, and reduces medical men to the level of quacks. Dr. Paterson uses a happy illustration in reference to this popular delusion, when he says that, in the vulgar mind, diseases are like rats in a house—you require to poison them to get rid of them.

The book has scattered throughout it illustrative anecdotes, which lighten the way. It is clearly printed and well bound. We highly recommend it to all teachers. They will find in it invaluable material for teaching purposes.

Gospel Manual. Grade III. of the 'Mimpriss System of Graduated Simultaneous Instruction.' London: 'The Systematic Bible Teacher' Depository, 67, Paternoster Row.

The fact that this little manual has reached its eighth edition shows the favour which it has deservedly received at the hands of teachers and students. To those who are not practically acquainted with the details of the system on which the book is based, a careful perusal of the introduction—in which an ideal lesson is fully described—will be both interesting and instructive. It may be well to mention that the manual consists of one hundred lessons, which deal with the whole Gospel history, and are carefully harmonised and arranged in chronological order. Each page is divided into three columns, the middle one containing the lesson, compiled from the four Gospels; the first the geographical questions, parallels, lessons, etc., in connection therewith; and the third a series of explanatory notes and illustrative remarks—all evidently arranged by one whose acquaintance with Gospel history is as wide as his knowledge of Sunday-school requirements. The only failing under which the volume labours is the smallness of print necessitated by its present size. If the book were made larger, and the size of type correspondingly increased, we feel sure the change would be welcomed by the greater proportion of its readers.

Sundry Attacks on Private Schools and Strictures Thereon. By Richard W. Hiley, M.A. London: Longmans, Green and Co.

The proximate *raison d'être* of this book seems to have been some disparaging remarks anent private middle-class schools made at the meetings of the National Society for the Advancement of Social Science, in 1875, 1876, and 1883, and also in the columns of the press during the same period. The sweeping nature of these strictures may be gathered from the fact that one speaker described private schools as being 'the speculation of men and women without culture, without elevation of character, often without manners—men who have undertaken to teach without having learned anything'; and another said that any one, 'whatever his qualification, may open a school, and, provided that he can induce parents to believe in him, may conduct it as he pleases, with what assistants he pleases, and with what modicum of real teaching he can or will give. . . . It is on the ignorance and helplessness of the parents that educational quackery thrives.'

In reply to these condemnatory remarks Mr. Hiley writes strongly, and to the purpose. He frankly owns that there are black sheep amongst private schoolmasters as in every other profession, but strongly deprecates the injustice of denouncing the *whole* class for the sins of the few. Then, as some of the most pronounced adverse critics *were* masters of large public schools, he carries the war into the enemies' quarters by pertinently inquiring if public-school education as given in great establishments, such as Rugby and Harrow, is regarded as immaculate by those who have tried it. Mr. Hiley, by advancing the testimony of the Rev. Sidney Smith, Anthony Trollope, and Serjeant Ballantine, conclusively answers this question in the negative. We must refer our readers who are interested in the question of private middle-class schools to the booklet itself for fuller details; but before closing our remarks we would emphasize one point to which Mr. Hiley refers. This point is the tendency in the present day in certain quarters to use the expressions 'adventure' and 'adventurer' in connection with private schoolmasters and their establishments in a way that conveys reproach. Mr. Hiley conclusively proves the absurdity of this practice by showing that those very schools—Harrow, Rugby, and the like, considered to be the very antitheses of private adventure schools—have all the trade aspects which constitute an adventure school inherent in themselves, they being to all intents and purposes but an aggregation of private schools, kept by the various house masters. Mr. Hiley has our sympathies as the defender of a class which numbers amongst its component units some of the most energetic and most advanced practical educationalists of the day.

Swift's 'Gulliver's Travels.' Edited by T. Parry, F.R.G.S. Longman's Modern Series. London: Longmans, Green and Co.

This issue of Swift's celebrated work has been carefully edited and prepared for school use, and being well annotated and illustrated, affords a reading book rather out of the ordinary school run, to be appreciated accordingly.

An Introduction to the Study of Shakspeare and Milton. London and Liverpool: George Philip and Son.

From a memorandum accompanying this volume, we gather that it has been written and arranged with the view of affording teachers an opportunity of introducing their pupils to the study of Shakspeare and Milton in a more comprehensive and systematic manner than is the case when any single play or poem is studied to the exclusion of the rest. The plea is made that, considering the necessarily limited time that can be given to the study of Shakspeare and Milton, even in the best schools, more benefit would be derived from a judicious selection than from the study of any single part. Though we admit there is much truth and force in this statement, we very much doubt if teachers, at any rate, in upper and middle-class schools, are to any great extent free agents in the matter. In those schools the study of Shakspeare or Milton is regulated simply by the particular examination for which the students are being prepared, so that as long as the examination councils of management set single plays and poems, so long will teachers be obliged to confine themselves in a similar manner. We do not wish to imply that in our opinion the study of single plays should be discontinued. We hold quite the reverse, and consider that a lad who has during his school-days carefully gone through two or three plays, is fully prepared in after years to read with intelligence and advantage to himself the remaining works, should he have any inclination so to do.

For schools, however, in which it is possible and advisable to use excerpts, the present volume is admirably adapted, the selections being judiciously made, the notes and critical reviews copious and thorough, and the book being illustrated with numerous wood-cuts.

Dictionary of the Portuguese Language. In two parts:—(1) Portuguese-English; (2) English-Portuguese. By Alfred Elwes. London: Crosby Lockwood and Co.

This, the latest addition to that estimable series of manuals known as the Weale Series, is a thoroughly serviceable volume. The compiler—Mr. Alfred Elwes—has had much experience in similar work, and has evidently kept well in view that idea of utility which is the distinguishing feature of the series. We have pleasure in recommending it as a clearly-printed, and, as far as we have tested it, an accurate dictionary of the Portuguese tongue.

Poynter's South Kensington Drawing Books. Human Figure, Elementary. Books I., II., III., and IV. London: Blackie and Son.

These are the first four books of an elementary series on the human figure, and it would be difficult—if not well-nigh impossible—to devise a more practical and serviceable set. Book I. contains a series of examples of the various parts of the face, based on studies taken from the colossal statue of David, by Michael Angelo; Book II. deals with heads, full-faced and profile; whilst Book III. furnishes numerous examples of hands, and Book IV. of feet. As all the examples have been taken from celebrated statues, illustrative of the highest Greek art, and the drawings have been made under the personal direction of Mr. Edward Poynter, R.A., there is no fear that the student who uses these books will have anything to unlearn in style or treatment.

A Course of Simple Object Lessons for Infants. Second Series. By W. Hewitt, B.Sc. London: Longmans, Green and Co.

This little book contains a series of thirty lessons on subjects carefully selected to suit the capacities of children six or seven years of age. Each lesson is treated in considerable detail, and many of them contain hints for interesting supplementary lessons, which will prove useful either in extending the course, should that be thought necessary, or as substitutes for those lessons which may be considered unsuitable in certain cases. We have pleasure in recommending the little book to the attention of teachers.

The Latin Handbook of Passages set at Civil Service and other Examinations. By W. K. Dalgleish, B.A. London: Longmans, Green and Co.

This handbook is apparently one of a series of open competition handbooks now in preparation under the editorship of W. J. Chetwode Crawley, LL.D., and will, in our opinion, prove of immense service to those teachers whose task it is to prepare candidates in Latin for any of the great open competitions. It contains all the important passages set for many years past at the examinations held by the Civil Service Commission and at the Army Entrance examination, and the book shows abundant evidence in its careful arrangement and attention to detail of being the work of a practical teacher. The indexes at the end, being complete and copious, enable the teacher with very little difficulty to form an estimate of the kind of Latin pieces usually selected for translation at sight at the various examinations.

The Student's Proper Psalms, being Notes, Historical and Explanatory. By the Rev. G. W. Wall, M.A., Incumbent of Bickerstaffe. London: Walter Smith.

Those who desire a concise, interesting, and, we believe, trustworthy manual, explanatory of the Psalms as they are appointed to be read in the service of the Church of England, can hardly do better than procure this volume. The Rev. G. W. Wall is to be congratulated on having produced a work both scholarly and understandable by all—a regrettably rare combination. The notes are concise without baldness, and show abundant evidence of careful and laborious research.

Exercises in Arithmetic. Standards I.-VII. By George Ricks, B.Sc. Lond. 'The Modern School Arithmetics.' London: Cassell and Company, Limited.

This series, up to Standard VII., seems excellently adapted for its intended purpose, being carefully graduated, clearly printed, and serviceably brought out. The examples are very copious and the miscellaneous questions and test exercises at the end of each book are well calculated to emphasize the more important rules, and to serve for examinational purposes. It may be as well, however, to mention that Standard VII. has not been quite altered to suit the requirements of the 1884 Code, as it contains discount and stocks.

Probably, too, in a fresh issue that eyesore to all teachers—the insertion of lists of errata and alterations,—which at present disfigures the last two standards, will be removed. When this has been done, the series may be correctly described as being adapted to the latest requirements of the Code.

Cassell's Modern School Drawing Copies. Adapted to the requirements of the Science and Art Department. First and Second Grade—**Freehand.** London: Cassell and Company, Limited.

These packets of drawing copies deserve commendation, being well printed on stout, serviceable card. Each set contains twelve cards, and, as the latter have examples on both sides, twenty-four drawing-copies. The designs are carefully graduated throughout, and seem admirably adapted to assist the learner in acquiring that facility and accuracy of pencil manipulation which is the desideratum in freehand drawing.

She Stoops to Conquer. Edited by Harold Littledale, B.A. Blackie's School Classics. London: Blackie and Son.

This issue of Goldsmith's humorous play is brought out in the excellent characteristics of the publishing firm whose imprint it bears. In type, arrangement, explanatory notes, paper, and, indeed, in all respects it is an ideal school book.

Readings from the Spectator. Being a selection of papers contributed by Addison. With Notes. London: Blackie and Son.

We have pleasure in recommending this book to the notice of all teachers desiring an interesting and instructive reading-book for the upper standards in their schools. It would be gilding fine gold to say anything in commendation of the subject-matter: suffice it to say that whoever has made the selections understood school requirements and has done his work with care and judgment. The biographical sketch at the commencement of the volume, and the explanatory lists of difficult words, Latin derivatives, etc., at the end, complete a very serviceable addition to school literature.

The Practical Arithmetical Test Cards. By P. Parkington. Wigan: R. Platt. London: Simpkin, Marshall and Co.

This is a set of Cards for Standards II.-VII., in six packets of thirty-six cards each, with two copies of answers to each packet. The compiler's aim has been to provide a set, which, while keeping within the limits of the Code, presents difficulties somewhat greater than the cards in use by the majority of inspectors. As an alternative set they will prove useful, the examples being, as the name indicates, *practical*, but a due admixture of easier examples would have rendered them still more worthy of the name. The set is well printed, and has different coloured cards for each standard.

Code Standard English Grammar. Part V. C. P. Mason, B.A. London: Bell and Son.

This is a very good sequel to the parts of this Grammar already noticed in these columns. It presents all the work required in word-building in Standards V.-VI. in a clear and intelligible form. Numerous examples are provided for practice, and the method indicated of using the Latin prefixes with a number of common roots will, if followed, be sure to add considerably to the intelligence of children using the book.

Sight-Singing for Schools, and Elements of the Theory of Music. National Society's Depository.

In many respects these form an excellent manual of practical and theoretical music for schools and pupil teachers. The sight-singing is based upon the staff notation, and the 'movable doh.' Much, therefore, of what is specially valuable in the sol-fa notation, viz., the principles of 'tonal relationship' and 'mental effect,' is incorporated in this course; but it is much to be regretted that the names used by solfaists, and so universally known, are discarded in favour of others which appear to be a compromise between those of the 'fixed doh' and the 'tonic-solfa.' Thus, instead of *Doh, Ray, Me, Fah, Soh, Lah*, and *Te*, we have the names, *Do, Ra, Me, Fa, So, La*, and *Te*. The course is carefully graduated, and contains a large number of suitable songs and exercises.

The account of the minor scale in its various forms (Chapter IV., Elements of the Theory of Music) can scarcely be regarded as quite satisfactory, nor is the statement that 'the minor scale is formed of the same sounds which constitute the major scale, but taken in a different order,' scientifically correct.

Waiving these points, however, as belonging rather to the theorist than to the practical teacher, the work may be safely recommended as a valuable text-book.

Imperial Handbooks of English History: (*a*) England under the Normans. (*b*) England under the Tudors. By Rev. R. O. Thomas. London: Thomas Murby.

The plan adopted by Mr. Thomas in compiling these handbooks is sure to be appreciated by students preparing for examinations, and any who may use them will feel glad that they have had them introduced to their notice. A brief sketch of each of the reigns of the several periods is first given. The second part is occupied with the principal events, treated at greater length. Under such headings as wars, treaties, laws, commerce, customs, biographical sketches, etc., there is no part of the history on which questions can be formed which has been overlooked. Still further aids in the shape of maps, tables, and summaries have been added, rendering the study easy and pleasant, while an ample assortment of questions from various examinations (pupil teacher, civil service, and university local) provides opportunities for testing the knowledge obtained. We very cordially recommend the volumes.

Chambers's Historical Readers. Books I. and II. London and Edinburgh: W. and R. Chambers.

These are enlarged editions of these popular Readers, and are now perfectly suited to the requirements of the last circular respecting the size of reading-books. They are well-written, suitably illustrated, strongly bound, and properly adapted for the standards for which they have been prepared.

Chambers's Graduated Readers. Book I. London and Edinburgh: W. and R. Chambers.

The requirements of the Department have necessitated changes in most of the reading-books in use. Some additional pages were needed in the Graduated Reader, and the publication of the enlarged edition gives us an opportunity of noticing its merits and suitability for use in Standard I. The book is very attractive in all its features, and a child cannot fail to like the book, with its gems of illustrations, its pretty stories, and pleasant rhymes. Teachers in need of a good reader for Standard I. should see the 'Graduated.'

The Promised Land: A Service of Praise compiled by T. Austin. London: Wesleyan Methodist Sunday School Union; Curwen and Sons.

This 'Service of Song' comprises some excellent hymn-tunes by well-known composers, together with original compositions by the compiler. We are sorry to be obliged to say that the original productions are by no means the best. The accompanied solos are fairly good, but the sanctus, which contains in the third score an unnecessarily doubled leading-note, in addition to consecutive perfect fifths between bass and tenor in stepwise similar motion, and ''Tis the Church triumphant singing,' are weak specimens of four-part harmony.

Carols for Christmas Services. The Children's Home, Bonner Road. Wesleyan Methodist Sunday School Union.

It would be out of place to criticize as a musical composition this little book, containing half-a-dozen carols, with words and music, published at a penny, in aid of the Children's Home. In furtherance of this laudable object, we can only hope that the book will have a wide circulation.

Cornhill Magazine. June, 1884. London: Smith, Elder and Co.

The June issue of this well-known magazine contains much that is fresh and interesting. 'Dr. Greatrex's Engagement' is a striking story of the effect produced upon nervous, highly-strung temperaments by the perusal of medical works on insanity. The article entitled 'My

Arab,' which depicts in simple and unexaggerated language the daily life of the average London *gamin*, will be read with considerable interest, now that the condition of the London poor is attracting so much attention.

Italian Primer, with Exercises. By the Rev. A. C. Clapin, M.A. London: George Bell and Sons.

This concise and well-arranged little book will, if we mistake not, be heartily welcomed by teachers of Italian, and may perhaps encourage many students to take up the language as one of their subjects for examination. The author is already favourably known as a writer of French and German Grammars for school use, and we doubt not that the present work will meet with the same appreciation.

Enunciations of Propositions in Geometrical Conic Sections. By W. H. Besant, M.A., Sc.D., F.R.S. Cambridge: Deighton, Bell and Co.

This book contains the enunciation of the propositions in geometrical conic sections, together with the figures and definitions appertaining to them. The little volume calls for no review save that it is well printed, and the figures drawn with clearness and exactitude.

Gill's New Music for the Code 1883. By R. H. Macartney, A.Mus. T.C.L.

A series of Tests and Schools Songs, arranged in three books. Being printed in both staff and sol-fa notations, these books will be found useful in most schools. The style of printing is excellent, and the absence of the typographical errors which deface so many of the collections of school songs recently produced shows that the books before us have been carefully prepared.

The songs, especially in Part III., are pleasing and melodious, and are set to good standard poetry. We have no hesitation in saying that the teacher will find these songs a valuable addition to the *repertoire* of school music.

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Health and Education at South Kensington.

THE idea of holding an exhibition of the various appliances connected with Health and Education was a happy one, and has already proved to be a great success. At the first glance many failed to see any reason why Education should be included in the programme of this year's display at South Kensington, but a moment's reflection will show how intimately education is connected with the proper appreciation of hygienic laws and appliances. Indeed, the first thought that suggests itself to an intelligent visitor on entering the Health Exhibition is that education alone has rendered such an exhibition possible. A few years ago the public mind was so ill-informed on matters relating to science and sanitation that such a collection of objects as is now to be seen at the exhibition would have attracted no attention. But thanks to the advance in education all along the line the great success of the Fisheries Exhibition seems likely to be surpassed by that of the present year. It is also to a further development of popular education that we must look for an extension of sanitary knowledge among the masses, and for that improvement of the national health which all desire to see accomplished.

An ordinary visitor to the exhibition at the present time (June 21st) would probably fail to see any of the educational exhibits, except those, perhaps, contributed by the enterprising little kingdom of Belgium. Indeed, it cannot be truly said that the educational section of the exhibition is yet open. High up in the gallery of the Albert Hall, remote from the more attractive parts of the exhibition are to be found the stalls of various well-known publishers and school furnishers, and in the Belgian Court is an interesting and unique collection of school-work and school-appliances. But the main part of the educational section is to be shown in the new buildings of the City and Guilds Central Institute, which are now nearly completed. By the time these lines are in the hands of our readers, His Royal Highness the Prince of Wales, the President of the exhibition, will have declared the section open. The great interest taken by the Prince in everything relating to the welfare and education of the people was shown by his presence at the inauguration of the International Juries immediately after his return to England, and by the active, personal interest he has taken in the work of organising the present exhibition. It will therefore not be our aim in the present notice to offer any criticisms on the objects in the education section or on their arrangement, but rather to give a general outline of the character and position of the exhibits already exposed to view.

Entering the building at the main entrance in Exhibition Road the visitor in search of the educational appliances must make his way to the northern side of the gardens, either through the central avenue or by the eastern gallery, until he reaches the great conservatory. He will pass on his way innumerable specimens of stoves, fire-places, and cooking-ranges, and if the day be hot will be glad to pass to the cooler air of the Albert Hall. Having arrived in the corridor, he may, if he has time to spare, take his turn for the lift, by which he will be gratuitously wafted aloft to the higher region dedicated to education. Here the visitor will find sufficient to occupy his attention for many hours. School desks innumerable are there, some so complicated in form and adjustments that we presume they combine the scientific principles of physiology with the discomfort of the scholar. School maps, scientific apparatus, school-books, blackboards, and other heavy articles of school furniture are also here exhibited in bewildering profusion, and, we regret to say, without any arrangement enabling the visitor to make a comparison of the merits of the same class of objects by different makers. Many of the appliances here shown are new, and not a few are successfully designed to improve the health of scholars and teachers. Among the principal exhibitors we notice Hammer, Edwards, Stanford, Northern Educational School Furnishing Company, Educational Supply Association, Gill and Sons, Joseph Hughes, and others. The specimens of single desks are numerous, and are infinitely superior to the so-called dual desks which appear to combine all the disadvantages of expensiveness and inconvenience. We observe that in the present exhibition the marked prices of school apparatus take a much wider range than heretofore, the extension being in both directions, some towards cheapness and others, *e.g.*, the 'University' desks, towards excessive cost.

It is a distinct loss that the educational exhibits of different countries cannot be seen in juxtaposition to each other. For example, it would have been much better if the school desks of all countries had been shown together, and the same is true of the maps and physiological models. It is by comparison only that the relative merits of the various specimens can be properly assessed, and such an arrangement as

we desiderate would have greatly facilitated the work of the jurors. We understand that the obstacle to this better arrangement of exhibits was the desire for each country to keep its contribution to the exhibition intact, and the same difficulty was raised in a less degree by even the English exhibitors.

A rapid and cursory glance at the arrangements in the City and Guilds Institute enables us to say that the teachers and educationalists who intend to visit the building, have a great treat in store. The rooms fitted up by the National Society, the London School Board, the Glasgow School Board, the Christian Brothers, and others, are full of novel and interesting specimens of school books, appliances, and school work. If we mistake not, this part of the exhibition will become highly popular, and will attract during the holidays a large number of practical teachers from all parts of the country.

Arrangements are in progress for holding, in connection with the Exhibition, an International Educational Conference, which is to take place on August 5th and following days. The presence in London of educational experts from all parts of the world will give to this conference a special interest. We hope that by means of this conference, it may be possible to arrive at a more accurate estimate of the comparative position of English and Continental schools, and that the excellencies and defects of foreign systems may be authoritatively noted for the benefit of the country. The following subjects for discussion have been proposed by the Committee of Management of the Conference, of which Lord Reay is Chairman.

1. *Conditions of Healthy Education.*—Under this head may be included—the consideration of the structure, fitting, and equipments of a School; gymnastics, and other physical exercises; the right apportionment of time to different subjects of instruction in schools of various classes; the indirect effect of pictorial or other decoration in improving the taste and cultivating the imagination, and in increasing the scholars' interest in their work.

2. *Infant Training and Teaching.*—(*a*) Kindergarten; (*b*) Instruction generally.—Under this head may be included—the right structure of schools and class rooms for very young children; the apparatus needed for play and for instruction; the exercises, mental or manual, best fitted to awaken the faculties; the distribution of time; pictures, decoration, collections of objects, etc.

3. *Technical Teaching.*—(*a*) Science; (*b*) Art; (*c*) Handicrafts; (*d*) Agriculture; (*e*) Domestic Economy.—Under this head may be included: (*a*) methods of teaching the different branches of physical and of natural science, the equipment of school laboratories, the value of experimental work by pupils, the organisation of evening science classes and of science schools, the connection between the teaching of pure and applied science; (*b*) the teaching of drawing and of colouring as a preparation for designing and decorative work; (*c*) the value of special and general workshop instruction in elementary, higher, and evening schools, the equipment of school workshops; (*d*) the teaching of agricultural science in elementary, in intermediate, and higher schools, in evening science classes, in special colleges, and in the universities, methods of teaching, experimental farms; (*e*) methods of teaching cookery in schools, *e.g.*, by book-lessons, by demonstrative lectures, and in school kitchens.

4. *Teaching of Music in Schools.*

5. *Museums, Libraries, and other Subsidiary Aids to Instruction in Connection with Schools.*—Under this head may be included the means of establishing and managing school libraries; the promotion with the help of the scholars or otherwise, of museums of art and science, illustrative of the local fauna, flora, industry, history, archæology, etc., etc.; School Savings Banks; botanical and other field excursions; visits to picture galleries and museums; voluntary evening classes for singing, recitations, etc.; and generally the means of connecting the influence of the school with home life and self-improvement.

6. *Training of Teachers.*—Under this head will be considered the right professional preparation for Teachers in—(*a*) Elementary; (*b*) Intermediate and Higher; (*c*) Special and Technical Schools.—The relative advantages of training in special institutions and in colleges for general education. Normal colleges: their constitution, conditions of admission, programme of studies. Apprenticeship. Model and practising schools. Universities and their relations to the training of teachers. Professorships and lectureships on education. Examination for diplomas and certificates. Legal recognition of such diplomas and certificates. Registration of teachers.

7. *Inspection and Examination of Schools.*—(*a*) By the State; (*b*) By the universities; (*c*) By other public bodies.

8. *Organisation of Elementary Education.*

9. *Organisation of Intermediate and Higher Education.*

10. *Organisation of University Education.*

11. *Systems of Public Instruction in various Countries.*

It will be seen that many of the subjects proposed for discussion are of the greatest importance to practical teachers. We shall, therefore, hope to give carefully summarised notices of such discussions in the PRACTICAL TEACHER, and to place before our readers during the present year all points of practical usefulness arising from the remarkable display at South Kensington.

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Correspondence.

To the Editor of the PRACTICAL TEACHER.

DEAR SIR,—I see that you have sometimes inquiries for the back Nos. of the 'P.T.', now out of print. I should take it as a favour if you would refer any inquirers to me, as I wish to dispose of mine from the commencement to the present month. The first two volumes are well bound in the cases supplied from the office; the rest are in numbers. I am leaving the profession and the country at the end of July, or I should not care to part with what I have found to be the most useful of professional papers, and which I have induced many friends to take in.

I am, yours truly,
W. HOWARD.

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Publications Received.

Bell and Sons (G.)—
The Code English Grammar. Part V. By C. P. Mason, B.A.

Bogue (David)—
The House of Lords: An Address by Sir J. Bennett.

Cassell and Co., Limited—
The Modern School Drawing Copies, First and Second Grade Freehand.

Educational Supply Association, The—
Practical Geometry.
Gray's 'Elegy,' with Notes.
Drawing to Scale Test Papers.
'Trades'—The Printer (Mounted).

Grant and Co.—
The New Code, 1884. By R. Gowing. With Notes, etc.

Heywood (John)—
Local Examination History. By Dr. R. S. Pringle.

Hodder and Stoughton—
How Sorrow was Changed into Sympathy. By Mrs. Prentiss.
Guides and Guards into Character Building. By Dr. Payne.

Letts, Son, and Co., Limited—
Letts' Illustrated Household Magazine for June.

Longmans and Co.—
A Course of Simple Object Lessons for Infants. By H. Hewitt, B.Sc.
Longman's Magazine for June.
Selections from Shakspere's 'King John.' By T. Parry, F.R.G.S.

Murby (T.)—
Murby's Scripture Manuals—Judges.
England under the Tudors. By Rev. R. O. Thomas.
England under the Normans. By Rev. R. O. Thomas.

Smith, Elder, and Co.—
The Cornhill Magazine for June.

Swale (T. S.), Widnes—
The Educational Franchise. By J. Hargreaves, F.C.S., F.A.S.

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Passages for Translation

From books not prescribed, set at the June Matriculation Examination of the London University.

1. Cn. Lentulus consul, cum in contione de Magni Pompei nimia potentia quereretur adsensusque ei clara voce universus populus esset, 'adclamate' inquit, 'Quirites, adelamate, dum licet; iam enim vobis impune facere non licebit.'

2. In nemus ire libet, pressisque in retia cervis
Hortari celeres per iuga summa canes,
Aut tremulum excusso iaculum vibrare lacerto
Aut in graminea ponere corpus humo.
Saepe iuvat versare leves in pulvere currus
Torquere et frenis ora fugacis equi.

3. Diogenes Syracusis, cum olera ei lavanti Aristippus dixisset 'si Dionysium adulari velles, ista non esses,' 'immo,' inquit, 'si tu haec esse velles, Dionysium non adularere.'

1. Τῇ μὲν γυναικὶ κάλλιον ἔνδον μένειν ἢ θυραυλεῖν, τῷ δὲ ἀνδρὶ αἰσχιον ἔνδον μένειν ἢ τῶν ἔξω ἐπιμελεῖσθαι.

2. Δίδοντος τοῦ Τιθραύστου πάμπολλα δῶρα, εἰ ἀπέλθοι ἐκ τῆς χώρας, ἀπεκρίνατο ὁ Ἀγησίλαος, Ὦ Τιθραύστα, νομίζεται παρ' ἡμῖν τῷ ἄρχοντι κάλλιον εἶναι τὴν στρατιὰν ἢ ἑαυτὸν πλουτίζειν, καὶ παρὰ τῶν πολεμίων λάφυρα μᾶλλον πειρᾶσθαι ἢ δῶρα λαμβάνειν.

3. Πολλῶν ταμίας Ζεὺς ἐν Ὀλύμπῳ,
πολλὰ δ' ἀέλπτως κραίνουσι θεοί·
καὶ τὰ δοκηθέντ' οὐκ ἐτελέσθη
τῶν δ' ἀδοκήτων πόρον εὗρε θεός.

Query Column.

RULES.

1. Each correspondent is restricted to *one question.* We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ **When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.**

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher, Pilgrim Street, Ludgate Hill, London, E.C.*

Arithmetic.

1. LL.—A tax of 5d. in the pound is paid on a certain sum, and a further tax of 1½ per cent. on the remainder. The sum now remaining is £31 2s. 9d. Find the original sum. (*Scholarship*, 1883.)

Amount left out of £1 after paying first tax = 19s. 7d.;
" " " " " second tax
= 98½ per cent. of 19s. 7d.

$$= \left(\frac{197}{240} \times \frac{197}{200}\right)£$$

$$= £\frac{38809}{48000};$$

£ £ s. d. £
∴ 38809 : 31 2 9 :: 9600 : Original sum.

197 20
622
12
7478
159

$$= \frac{159 \times 40}{197}£$$

$$= £\frac{6360}{197}$$

= £32 5s. 8$\frac{144}{197}$d. Ans.

2. INQUISITIVE.—A can beat B in a one hundred yards' race by 5 yards and C by 10 yards; by how many yards will B beat C? (*Edinburgh University Medical Preliminary*, 1884.)

A runs 100 yds. while B runs 95 yds.,
" " " " C " 90 " ;
∴ B " 95 " " C " 90 " ,
18
" " 100 " " C " $\left(\frac{90}{95} \times 100\right)$ yds.
19

$$= 94\frac{12}{19} \text{ yds.}$$

= 94$\frac{12}{19}$ yds.

∴ B will beat C by (100 − 94$\frac{12}{19}$) yds. = 5$\frac{7}{19}$ yds. in 100 yds.

3. O. H. F.—A model of the earth is made on a globe 30 ft. in radius. Express as the fraction of an inch the height of the highest mountain upon it, taking the earth's diameter as 7,946 miles, and the height of the highest mountain as 29,000 ft. (*Certificate Examination*, 1882.)

Radius of earth = 7946 miles ÷ 2
= 3973 miles;
miles. ft. ft.
∴ 3973 : 30 :: 29000 : Height on globe.
25

$$\therefore \text{Height} = \frac{30 \times 29000 \times 12}{3973 \times 5280} \text{ in.}$$

137 440
11

$$= \frac{7800}{10057} \text{ in.}$$

= ¾ in. nearly Ans.

4. M. R. S.—By selling £4500 in the India 5 per cent. stock at 112½, and investing the proceeds in Egyptian 7 per cent. stock, a person finds his income increased by £168 15s. What is the price of the latter stock?

Income in 1st case = 5 per cent. on £4500
= £225
" 2nd " = £225 + £168 15s.
= £393¾;
Amount realised for stock = £(112½ × 45)
= £5062½;

£ £ £
∴ 393¾ : 7 :: 5062½ : Price of Egyptian stock.
4 4
1575 28350
11 90
= £90. Ans.

5. GRATEFUL.—A man rows down a river 18 miles in 4 hours with the stream, and returns in 12 hours; find the rate at which he rows, and the rate at which the stream flows. (*Hamblin Smith.*)

Rate per hour with the stream $= \frac{1}{4}^{8}$ miles
$= 4\frac{1}{2}$,, ;
,, ,, against ,, $= \frac{1}{1}\frac{1}{2}$,, ;
$= 1\frac{1}{3}$,, ;
$\therefore$,, ,, of rowing $= (4\frac{1}{2} + 1\frac{1}{3})$ miles $\div 2$
$= 3$ miles ;
,, ,, ,, stream $= (4\frac{1}{2} - 3)$ miles
$= \underline{1\frac{1}{2}}$ miles.

Note.—Perhaps 90 per cent.

6. GENTIL.—If a person has £550 in the 3 per cent. stock at $81\frac{1}{4}$, and sell the same for $90\frac{3}{4}$, and with the proceeds buy $3\frac{1}{2}$ per cent. stock at $105\frac{7}{8}$, does he gain or lose in income by the transaction? (*Bradlake.*)

Income in 1st case $= 3$ per cent. on £550
$=$ £16 10s. :

£ £ £
$105\frac{7}{8}$: $90\frac{3}{4}$ :: 550 : Stock in 2nd case.

$$= \left(\frac{26\frac{1}{4}}{4} \times \frac{550}{1} \times \frac{2}{\cancel{847}}\right)\text{£}$$
$$= \frac{3300}{7}\text{£};$$

Income in the 2nd case $= 3\frac{1}{2}$ per cent. on $\text{£}\frac{3300}{7}$
$$= \left(\frac{3300}{7} \times \frac{7}{200}\right)\text{£}$$
$$= \underline{\text{£16 10s.}}$$

$\therefore$ Income is the same in both cases.

Note.—Reckoning brokerage in each transaction.

£ £ £
$106\frac{1}{8}$: $90\frac{3}{4}$ :: 550 : Stock in 2nd case.
$$= \frac{725 \times 550}{106 \times 8}\text{£};$$

Income in 2nd case $= \left(\frac{725 \times \cancel{88}}{106 \times 8} \times \frac{7}{\cancel{200}}\right)$ £
$$= \frac{55825}{3392}\text{£}$$
$$= \text{£16 9s. } 1\frac{1}{1}\frac{7}{3}\text{d.};$$

$\therefore$ Difference in income $= (\text{£16 10s.} - \text{£16 9s. } 1\frac{1}{1}\frac{7}{3}\text{d.})$ de-
$= \underline{10\frac{2}{1}\frac{3}{3}\text{d. decrease.}}$ [crease

7. J. EDWARDS.—A piece of metal weighing 12 cwt. 60 lbs. has been formed by compounding three metals in quantities, which by measure are as 5 : 3 : 2, but the weights of equal volumes of them would be as 7 : 11 : 13. What weight of each of the component metals has been used?—(*Lower Division*, October, 1883.)

Weights of the three metals are as,
$5 \times 7 : 3 \times 11 : 2 \times 13$;
As, 35 : 33 : 26 ;
$35 + 33 + 26 = 94$;
$\therefore$ Weight of 1st metal $= \frac{35}{94}$ of 12 cwt. 60 lbs.
$$= \frac{35 \times \cancel{1344}}{\cancel{94}} \text{ lbs.}$$
$$= \frac{24570}{47} \text{ lbs.}$$
$$= 522\frac{36}{47} \text{ lbs.}$$
$$= \underline{4 \text{ cwt. } 74\frac{36}{47} \text{ lbs.};}$$

,, 2nd ,, $= \frac{33 \times 702}{47}$ lbs.
$$= \frac{23166}{47} \text{ lbs.}$$
$$= 492\frac{42}{47} \text{ lbs.}$$
$$= \underline{4 \text{ cwt. } 44\frac{42}{47} \text{ lbs.};}$$

,, 3rd ,, $= \frac{26 \times 702}{47}$ lbs.
$$= \frac{18252}{47} \text{ lbs.}$$
$$= 388\frac{16}{47} \text{ lbs.}$$
$$= \underline{3 \text{ cwt. } 52\frac{16}{47} \text{ lbs.}}$$

8. J. E.—A sum of money doubles itself at compound interest in 4 years; how many fold will it be increased in 16 years?

Amount in 4 years = Twice original sum ;
,, 8 ,, = 4 times ,, ,, ;
,, 12 ,, = 8 ,, ,, ,, ;
,, 16 ,, = 16 ,, ,, ,, .

Note.—Perhaps 95 per cent.

9. MAGISTER.—Four horses and 6 cows together find sufficient grass on a certain field; and 7 cows eat as much as 9 horses; what must be the size of a field relatively to the former, which will support 18 horses and 9 cows? (*Barnard Smith.*)

9 horses eat as much as 7 cows,
$\therefore$ 4 ,, ,, ,, $\frac{7 \times 4}{9}$ cows
$= 3\frac{1}{9}$ cows,
4 horses and 6 cows ,, ,, $9\frac{1}{9}$ cows ;
18 horses ,, ,, 14 cows,
18 horses and 9 cows ,, ,, 23 cows ;
$\therefore$ Second field : First field :: 23 : $9\frac{1}{9}$,
:: $\underline{207 : 82}$.

10. ROCO.—The capital of a trading company consists of 4000 A shares of £80 each, and 2000 B shares of £25 each; in dividing the profits, 5 per cent. of the amount of each share is first paid, and then the remainder, if any, is divided equally amongst the shareholders. The profits of the undertaking in one year were £34,853 12s. $6\frac{1}{2}$d.; how much would be paid to the holder of an A share; and how much to the holder of a B share?—(*1st Stage Mathematics*, 1883.)

Total capital $= (\text{£80} \times 4000) + (\text{£25} \times 2000)$
$= \text{£320,000} + \text{£50,000}$
$= \text{£370,000}$;
5 per cent. on £370,000 $= \text{£18,500}$;
$(\text{£34,853 12s. } 6\frac{1}{2}\text{d.} - \text{£18,500}) \div 6000$
$= \text{£16,353 12s. } 6\frac{1}{2}\text{d.} \div 6000$
$= \text{£2 14s. } 6\frac{1}{1}\frac{7}{3}\frac{0}{6}\frac{4}{3}\text{d.}$;
$\therefore$ Holder of an A share receives 5 per cent. of £80
$+ \text{£2 14s. 6d.}$
$= \text{£4} + \text{£2 14s. 6d.}$
$= \text{£6 14s. 6d.}$;
Holder of a B share receives 5 per cent. of £25
$+ \text{£2 14s. 6d.}$
$= \text{£1 5s.} + \text{£2 14s. 6d.}$
$= \underline{\text{£3 19s. 6d.}}$

11. CUPIDITAS.—Two towns on a uniformly-flowing river are 27 miles apart; a steamboat takes an hour and a half on its down trip from one town to the other, and a row-boat three hours. The steamboat returns against the stream in one-tenth of the time that the row-boat takes. Required the velocity of the river and speed of boats in still water.

Rate per hour of steamboat with the stream
$= 27 \text{ miles} \div 1\frac{1}{2} = 18 \text{ miles}$;
Rate per hour of row-boat with the stream
$= 27 \text{ miles} \div 3 = 9 \text{ miles}$;
Rate of steamboat – Rate of river
$= 10$ times (Rate of row-boat – Rate of river),
$\therefore$ (18 miles – Rate of river) – Rate of river
$= 10$ times {(9 miles – Rate of river) – Rate of river},
18 miles – Twice rate of river $= 10$ times (9 miles
– Twice rate of river),
18 miles – Twice rate of river $= 90$ miles
– 20 times rate of river,
20 times rate of river – Twice rate of river
$= 90$ miles – 18 miles,
18 times rate of river $= 72$ miles,
$\therefore$ Rate of river per hour $= \underline{4 \text{ miles.}}$
Rate of steamboat per hour in still water $= (18 - 4)$ miles
$= 14$ miles ;
,, row-boat ,, ,, $= (9 - 4)$ miles
$= \underline{5 \text{ miles.}}$

Note.—The other query is a question in mensuration. You will find two methods of solution in our issue for May, 1882.

12. TUTUS DUM RECTUS.—If the year of the planet Mercury were exactly 87, that of Venus 225, and of the Earth 365 of our days, how many of our years would intervene between any two occasions on which the three planets would appear to a spectator from the sun to be in a straight line? (*Sonnenschein.*)

3 | 87, 225, 365
5 | 29, 75, 365
29, 15, 73
$\therefore$ L.C.M. $= 3 \times 5 \times 29 \times 15 \times 73$;

$$\therefore \text{ No. of years} = \frac{3\times5\times29\times15\times73}{365}$$
$$= 3\times29\times15$$
$$= 1{,}305. \quad \text{Ans.}$$

13. WELSHMAN.—A corn-merchant bought 121 quarters of wheat, and he sells it so as to gain 17½ per cent. on 26 quarters, and 13 per cent. on the remaining quantity, having previously tried to sell the whole at a uniform advance of 15 per cent., which would have brought him £4 5s. more than he actually received. What did the wheat cost him per quarter? (*Colenso.*)

Suppose cost price were £100 per quarter;
Then profit would have been £{(17½ × 26) + (13 × 95)}
= £(455 + 1235)
= £1690;
If sold at a uniform advance of 15 per cent., profit would have been £(15 × 121)
= £1815;
Difference of profits = £1815 − £1690
= £125;

£	£ s.	£	
125	4 5	1690	Cost price per qr.
5	20	4	
	85		
	17		

= 68s.
= £3 8s. Ans.

14. X. Y. Z.—A person buys an article and sells it so as to gain 5 per cent. If he had bought it at 5 per cent. less and sold it for 1s. less, he would have gained 10 per cent. Find the cost price. (*Brook Smith.*)

Suppose cost price of the article were £100;
Then selling price would have been £105;
If it had been bought at 5 per cent. less, cost price would have been £95;
If sold at a profit of 10 per cent. on £95, selling price would have been
£95 + £9 10s. = £104 10s.;
Difference between the two selling prices
= £105 − £104 10s.
= 10s.;
For difference of 10s. cost price would be £100,
∴ ,, ,, 1s. ,, ,, £10.

15. CAER GWENT.—A person buys tea at 6s. a lb., and also some at 4s. a lb. In what proportions must he mix them, so that, selling his tea at 5s. 3d. a lb., he may gain 20 per cent. on each lb. sold? (*Barnard Smith.*)

Cost price of mixture = 5s. 3d. × 120/100
= 6/5 of 5s. 3d.
= 4s. 4½d.;
Loss on 1st kind at this price = 6s. − 4s. 4½d.
= 1s. 7½d.
Gain on 2nd ,, ,, = 4s. 4½d. − 4s.
= 4½d.;

	d.	s. d.
∴ Quantity at 6s. : Quantity at 4s.	:: 4½	: 1 7½,
	:: 9	: 39,
	:: 3	: 13.

Note.—Perhaps 70 per cent.

16. A. M. (SOUTHAMPTON.)—A man has stock in the 3½ per cents. which brings him in £43 15s. a year. He sells out ⅞ of the whole at 112½, and invests the proceeds in railway debentures at 128¾. How much per cent. must the dividend of the debentures be, in order that his annual income may be diminished by 10s. 11½d., no brokerage being charged for the sale of the stock, but ¼ per cent. being charged for the purchase of the debentures? (*Excise Exam.*, November, 1881.)

⅛ of income = ⅛ of £43 15s. = £8 15s.;
£8 15s. − 10s. 11½d. = £8 4s. 0½d.;

£	£	£	
3½	8½	100	Stock sold out.
2	4		
7	35		
	5		

= £250.

£	£	£	
175	112½	250	Amount of Railway Debentures.
	8		
	900		
	7		

$$= \frac{7\times125}{4}\text{£}$$
$$= \text{£}218\tfrac{3}{4}.$$

£	£	£ s. d.	
218¾	100	8 4 0½	Dividend per cent. of debentures.
4	4	4	
875		32 16 3	
35		4	
		131 5 0	
		20	
		2625	
		75	

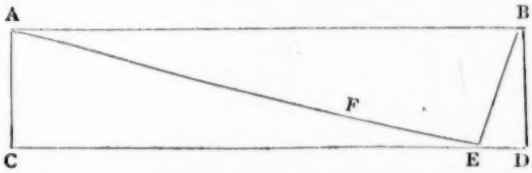
= £3 15s.

∴ Dividend of Debentures = 3¾ per cent.

Note.—Your writing is very good, and we believe it will obtain full marks at examinations.

Algebra.

1. AJAX—A lane runs parallel to the firing point and target of a rifle range, and is 200 yards from it. From the firing point to the target is 1,500 yards. At what distance from the end of the lane will a person hear the report of the gun and the clang of the bullet on the target simultaneously, the pace of the bullet compared with the pace of sound being as 4 : 3?



Let A represent the firing-point, B the target, and CD the lane (C being the end of the lane);
Also let E denote the position of the person hearing the report of the gun and the clang of the bullet on the target simultaneously;
When the bullet strikes the target the sound of the report has travelled ¾ of 1500 yds. = 1125 yds.;
Let A F represent this distance, and therefore the distance FE = the distance BE;

Let x = the distance F E or E B in yds.
And let y = ,, E D in yds.;
BE² = ED² + DB², (I. 47)
AE² = EC² + CA²;
∴ (1) $x^2 = y^2 + (200)^2$
(2) $(1125+x)^2 = (1500-y)^2 + (200)^2$

(1) $x^2 - y^2 = 40000$
(2) $1265625 + 2250x + x^2 = 2250000 - 3000y + y^2 + 40000$

(1) $x^2 - y^2 = 40000$
(2) $x^2 - y^2 + 2250x + 3000y = 1024375$

$$2250x + 3000y = 984375$$
$$6x + 8y = 2625$$
$$\therefore x = \frac{2625 - 8y}{6}.$$

$$(1)\ \left(\frac{2625-8y}{6}\right)^2 - y^2 = 40000$$
$$6890625 - 42000y + 64y^2 - 36y^2 = 1440000$$
$$28y^2 - 42000y = -5450625$$
$$y^2 - 1500y = -\frac{5450625}{28}$$
$$y^2 - 1500y + (750)^2 = 562500 - \frac{5450625}{28}$$
$$= \frac{15750000 - 5450625}{28}$$
$$= \frac{10299375}{28}$$
$$= 367834{\cdot}8214\ldots$$
$$y - 750 = \pm 606{\cdot}49\ldots$$
$$y = 750 \pm 606{\cdot}5 \text{ (nearly)}$$
$$\therefore y = 1356{\cdot}5, \text{ or } 143{\cdot}5.$$

$\therefore$ Distance ED = 143·5 yds.,
And ,, CE = (1500 − 143·5) yds.
= 1356·5 yds. Ans.

2. J. E. B.—A and B can do a piece of work in m days; A works n days alone, when B joins him, and both together finish the work in p days more; how long would either require to do it singly? (*Scholarship*, 1880.)

First Solution :—

Let x = time A can do the work in days,
And ,, y = ,, B ,, ,, ,, ;

Then (1) $\frac{1}{x}+\frac{1}{y}=\frac{1}{m}$
(2) $\frac{n}{x}+\frac{p}{m}=1$

(2) $\frac{n}{x}=1-\frac{p}{m}$
$=\frac{m-p}{m}$
$\frac{x}{n}=\frac{m}{m-p}$
$\therefore x=\frac{mn}{m-p}$.

(1) $\frac{1}{x}+\frac{1}{y}=\frac{1}{m}$
$\frac{m-p}{mn}+\frac{1}{y}=\frac{1}{m}$
$\frac{1}{y}=\frac{1}{m}-\frac{m-p}{mn}$
$=\frac{n-m+p}{mn}$
$\therefore y=\frac{mn}{n-m+p}$.

$\therefore$ A can do it alone in $\frac{mn}{m-p}$ days,
B ,, ,, $\frac{mn}{n-m+p}$ days.

Second Solution :—

A and B can do the work in m days,
$\therefore$,, ,, ,, in one day $\frac{1}{m}$ of the work,
,, ,, ,, ,, p days $\frac{p}{m}$,, ,, ;
$\therefore$ A does in n days $\left(1-\frac{p}{m}\right)$ of the work
$=\frac{m-p}{m}$,, ,,
,, ,, 1 day $\frac{m-p}{mn}$,, ,,
$\therefore$ A can do the work in $\frac{mn}{m-p}$ days;
B can do in 1 day $\left(\frac{1}{m}-\frac{m-p}{mn}\right)$ of the work
$=\frac{n-(m-p)}{mn}$,, ,,
$=\frac{n-m+p}{mn}$,, ,,
$\therefore$ B can do the work in $\frac{mn}{n-m+p}$ days.

3. CYCLOPS.—Solve :—

$x+\frac{1}{y}=5\frac{1}{2}$
$y+\frac{1}{x}=2\frac{1}{5}$

(1) $x+\frac{1}{y}=5\frac{1}{2}$
(2) $y+\frac{1}{x}=2\frac{1}{5}$

(1) $\frac{xy+1}{y}=\frac{11}{2}$
(2) $\frac{xy+1}{x}=\frac{11}{5}$

Dividing (1) by (2)}

$\frac{x}{y}=\frac{5}{2}$
$\therefore x=\frac{5y}{2}$.

(1) $\frac{5y}{2}+\frac{1}{y}=\frac{11}{2}$
$5y^2+2=11y$
$5y^2-11y=-2$
$y^2-\frac{11y}{5}=-\frac{2}{5}$
$y^2-\frac{11y}{5}+(\frac{11}{10})^2=\frac{121}{100}-\frac{2}{5}$
$=\frac{121-40}{100}$
$=\frac{81}{100}$
$y-\frac{11}{10}=\pm\frac{9}{10}$
$y=\pm\frac{9}{10}+\frac{11}{10}$
$\therefore y=2$, or $\frac{1}{5}$.

$x=\frac{5y}{2}$
$\therefore x=5$, or $\frac{1}{2}$.
$\therefore x=5, y=2$;
or, $x=\frac{1}{2}, y=\frac{1}{5}$.

4. ERO.—A sum of £19,950 if invested in the 4 per cents. would give an annual income of £8 8s. more than if invested in the 3 per cents. If, however, each stock were 1 per cent. higher in price, the former would give £9 17s. 11d. more. What was the price of each stock? (*Cambridge Junior Local*, 1883.)

Let x = Price of the 4 per cents.,
and ,, y = ,, ,, 3 ,, ;

Then, (1) $\frac{19950\times4}{x}-\frac{19950\times3}{y}=\frac{42}{5}$
(2) $\frac{19950\times4}{x+1}-\frac{19950\times3}{y+1}=\frac{8775}{485}$

(1) $\frac{1900}{x}-\frac{1425}{y}=\frac{1}{5}$
(2) $\frac{168}{x+1}-\frac{126}{y+1}=\frac{3}{485}$

(1) $5(1900y-1425x)=xy$
(2) $48(168y+168-126x-126)$
$=(x+1)(y+1)$
$48(168y-126x+42)=xy+x+y+1$
$8064y-6048x+2016=xy+x+y+1$
$8063y-6049x+2015=xy$
$\therefore 9500y-7125x=8063y-6049x+2015$
$1437y=1076x+2015$
$\therefore y=\frac{1076x+2015}{1437}$.

(1) $\frac{1076x+2015}{1437}\times9500-7125x=\frac{(1076x+2015)x}{1437}$
$10222000x+19142500-10238625x=1076x^2+2015x$
$1076x^2+2015x+16625x=19142500$
$1076x^2+18640x=19142500$
$269x^2+4660x=4785625$
$x^2+\frac{4660x}{269}+(\frac{2330}{269})^2=\frac{4785625}{269}+\frac{5428900}{269^2}$
$=\frac{1287333125+5428900}{269^2}$
$=\frac{1292762025}{269^2}$
$x+\frac{2330}{269}=\frac{\pm35955}{269}$
$x=\frac{\pm35955-2330}{269}$
$=\frac{33625}{269}$, or $-\frac{38285}{269}$
$\therefore x=125$, or $-\frac{38285}{269}$.

$\therefore$ Price of the 4 per cents. = £125;
,, 3 ,, $=\frac{(1076\times125)+2015}{1437}$ £
$=\frac{134500+2015}{1437}$ £
$=\frac{136515}{1437}$ £
= £95.

5. T. ALDOUS.—If x^2+ax+b and x^2+cx+d have a common measure of the form of $x+e$, show that $e=\frac{b-d}{a-c}$. (*Scholarship*, 1880.)

If $x+e$ measure x^2+ax+b and x^2+cx+d, it will also measure their difference;

$\therefore$ $x+e$ will measure $x^2+ax+b-(x^2+cx+d)$,
" " " $x^2+ax+b-x^2-cx-d$,
" " " $ax-cx+b-d$,
" " " $(a-c)x+b-d$,
" " " $x+\frac{b-d}{a-c}$;

$\therefore$ $e=\frac{b-d}{a-c}$.

Note.—(1) You have worked the other question correctly, and your reasoning is sufficiently explicit, but there are *numerous* ways of arranging the digits. (2) With great diligence you might master the two languages in the time: *Dr. Smith's* 'Principia Latina,' Part I.; *De Fiva's* 'French Grammar.' (3) We believe your writing will obtain full marks at the Scholarship Examination; it is *very good*.

6. ST. HELENA.—Solve:—

$$\frac{3-2x}{1-2x}-\frac{2x-5}{2x-7}=1-\frac{4x^2-1}{7-16x+4x^2}.$$

(*Todhunter.*)

$$\frac{3-2x}{1-2x}-\frac{2x-5}{2x-7}=1-\frac{4x^2-1}{7-16x+4x^2}$$

$$\frac{3-2x}{1-2x}-\frac{5-2x}{7-2x}=\frac{7-16x+4x^2-4x^2+1}{7-16x+4x^2}$$

$$\frac{(3-2x)(7-2x)-(5-2x)(1-2x)}{(1-2x)(7-2x)}=\frac{8-16x}{7-16x+4x^2}$$

$$\frac{21-20x+4x^2-5+12x-4x^2}{7-16x+4x^2}=\frac{8-16x}{7-16x+4x^2}$$

$$16-8x=8-16x$$
$$16x-8x=8-16$$
$$8x=-8$$
$$\therefore\ x=-1.$$

7. SOLICITOR.—If x, y, z be the p^{th}, q^{th}, and r^{th} terms of a Harmonical Progression—show that

$$(r-q)yz+(p-r)xz+(q-p)xy=0.$$

Let a denote the 1st term, and d the difference.

$$\therefore\ \frac{1}{x}=a+(p-1)d,$$
$$\frac{1}{y}=a+(q-1)d,$$
$$\frac{1}{z}=a+(r-1)d;$$

$$\frac{1}{x}-\frac{1}{z}=(p-r)d,$$
$$\frac{1}{z}-\frac{1}{y}=(r-q)d,$$
$$\frac{1}{y}-\frac{1}{x}=(q-p)d;$$
$$z-x=(p-r)xzd,$$
$$y-z=(r-q)yzd,$$
$$x-y=(q-p)xyd,$$

Adding, $0=(p-r)xzd+(r-q)yzd+(q-p)xyd,$

$\therefore$ $(r-q)yz+(p-r)xz+(q-p)xy=0.$

8. BLACKBIRD.—If the H. M. between each pair of the numbers a, b, c be in A. P., then b^2, a^2, c^2 will be in H. P.; and if the H. M. be in H. P., b, a, c will be in H. P.

H. M. $=\frac{2ab}{a+b}, \frac{2bc}{b+c}, \frac{2ca}{c+a}$; (Arithmetical Progression.)

$$\therefore\ \frac{2bc}{b+c}-\frac{2ab}{a+b}=\frac{2ca}{c+a}-\frac{2bc}{b+c}$$

$$\frac{bc}{b+c}-\frac{ab}{a+b}=\frac{ca}{c+a}-\frac{bc}{b+c}$$

$$\frac{abc+b^2c-ab^2-abc}{(b+c)(a+b)}=\frac{abc+ac^2-bc^2-abc}{(b+c)(c+a)}$$

$$\frac{b^2(c-a)}{a+b}=\frac{c^2(a-b)}{c+a}$$

$$b^2(c^2-a^2)=c^2(a^2-b^2)$$
$$b^2c^2-a^2b^2=a^2c^2-b^2c^2$$
$$2b^2c^2=a^2b^2+a^2c^2$$
$$\frac{2}{a^2}=\frac{1}{c^2}+\frac{1}{b^2}$$
$$\frac{1}{a^2}-\frac{1}{b^2}=\frac{1}{c^2}-\frac{1}{a^2};$$

$\therefore$ b^2, a^2, c^2 are in Harmonical Progression.

Again H. M. $=\frac{2ab}{a+b}, \frac{2bc}{b+c}, \frac{2ca}{c+a}$; (Harmonical Progression)

$\therefore$ $\frac{a+b}{2ab}, \frac{b+c}{2bc}, \frac{c+a}{2ca}$; (Arithmetical Progression)

$$\therefore\ \frac{b+c}{2bc}-\frac{a+b}{2ab}=\frac{c+a}{2ca}-\frac{b+c}{2bc}$$

$$\frac{b+c}{bc}-\frac{a+b}{ab}=\frac{c+a}{ca}-\frac{b+c}{bc}$$

$$\frac{1}{c}+\frac{1}{b}-\left(\frac{1}{b}+\frac{1}{a}\right)=\frac{1}{a}+\frac{1}{c}-\left(\frac{1}{c}+\frac{1}{b}\right)$$

$$\frac{1}{c}+\frac{1}{b}-\frac{1}{b}-\frac{1}{a}=\frac{1}{a}+\frac{1}{c}-\frac{1}{c}-\frac{1}{b}$$

$$\frac{1}{c}-\frac{1}{a}=\frac{1}{a}-\frac{1}{b};$$

$\therefore$ b, a, c are in Harmonical Progression.

9. JACOBUS.—Solve:

$$\frac{\sqrt{a+x}-\sqrt{a-x}}{\sqrt{a+x}+\sqrt{a-x}}=b.$$ (*Scholarship*, 1880.)

$$\frac{\sqrt{a+x}-\sqrt{a-x}}{\sqrt{a+x}+\sqrt{a-x}}=\frac{b}{1}$$

$\frac{\text{Denominator}+\text{Numerator}}{\text{Denominator}-\text{Numerator}}$,

$$\frac{2\sqrt{a+x}}{2\sqrt{a-x}}=\frac{1+b}{1-b}$$
$$\frac{\sqrt{a+x}}{\sqrt{a-x}}=\frac{1+b}{1-b}$$

Squaring,

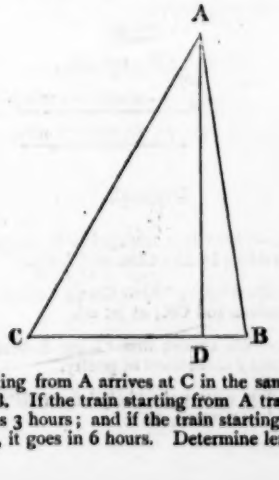
$$\frac{a+x}{a-x}=\frac{1+2b+b^2}{1-2b+b^2}$$

$\frac{\text{Numerator}-\text{Denominator}}{\text{Numerator}+\text{Denominator}}$,

$$\frac{2x}{2a}=\frac{4b}{2+2b^2}$$
$$\frac{x}{a}=\frac{2b}{1+b^2}$$
$$\therefore\ x=\frac{2ab}{1+b^2}$$

Note.—Perhaps 90 per cent.

10. TEACHER.—Let A and B be two stations, and C the terminus of two lines AC and BC, and let angle at C be one of 60°. The perimeter of figure is 200 miles.



A train starting from A arrives at C in the same time as one starting from B. If the train starting from A travel by way of B to C, it takes 3 hours; and if the train starting from B go by way of A to C, it goes in 6 hours. Determine length of sides.

Let x = Distance AB in miles,
" y = " BC " ,
and " z = " AC " ;
Rate of 1st train : Rate of 2nd train :: $z : y$;
Also " : " :: $x+y : \frac{1}{2}(x+z)$;

$$\therefore z : y :: x+y : \tfrac{1}{2}(x+z)$$
$$\tfrac{1}{2}z(x+z) = y(x+y)$$
$$\underline{z(x+z) = 2y(x+y).}$$

Again, $AB^2 = BC^2 + AC^2 - 2BC.CD$, (II. 13.)
Now, angle ACB = 60°; ∴ Angle CAD = 30°;
Wherefore triangle ACD is half an equilateral triangle;

$$\therefore CD = \tfrac{1}{2} AC.$$
$$\therefore x^2 = y^2 + z^2 - \left(2y \times \frac{z}{2}\right)$$
$$= \underline{y^2 + z^2 - yz.}$$

Then,
$$\left.\begin{array}{l} (1)\ x+y+z = 200 \\ (2)\ x^2 - y^2 - z^2 + yz = 0 \\ (3)\ z(x+z) = 2y(x+y) \end{array}\right\}$$
$$(2)\ x^2 - y^2 - z^2 + yz = 0$$
$$(x^2 - y^2 - z^2 - 2yz) + 3yz = 0$$
$$(x+y+z)(x-y-z) + 3yz = 0$$

Substituting from (1)

$$200(x-y-z) + 3yz = 0$$
$$x - y - z = -\frac{3yz}{200}$$
$$(200 - y - z) - y - z = -\frac{3yz}{200}$$
$$200 - 2y - 2z = -\frac{3yz}{200}$$
$$\underline{400y + 400z - 3yz = 40{,}000.} \quad (4)$$

(3) $$z(x+z) = 2y(x+y)$$
$$z(200 - y - z + z) = 2y(200 - y - z + y)$$
$$z(200 - y) = 2y(200 - z)$$
$$200z - yz = 400y - 2yz$$
$$\underline{400y - 200z - yz = 0.} \quad (5)$$

$$\left.\begin{array}{l} (4)\ 400y + 400z - 3yz = 40{,}000 \\ (5)\ 1200y - 600z - 3yz = 0 \end{array}\right\}$$
$$-800y + 1000z = 40{,}000$$
$$5z - 4y = 200$$
$$\therefore \underline{z = \frac{4y + 200}{5}}$$

Substituting this value of z in (5):—

$$400y - 200\left(\frac{4y+200}{5}\right) - y\left(\frac{4y+200}{5}\right) = 0$$
$$400y - 40(4y+200) - \frac{4y^2}{5} - 40y = 0$$
$$360y - 160y - 8000 - \frac{4y^2}{5} = 0$$
$$\frac{4y^2}{5} - 200y = -8000$$
$$y^2 - 250y = -10{,}000$$
$$y^2 - 250y + (125)^2 = 15{,}625 - 10{,}000$$
$$= 5625$$
$$y - 125 = \pm 75$$
$$y = \pm 75 + 125$$
$$\therefore \underline{y = 200, \text{ or } 50.}$$

The value 200 is inapplicable.

$$\therefore \underline{y = 50.}$$
$$z = \frac{4y+200}{5} = \frac{400}{5} = 80;$$
$$\underline{x = 200 - y - z = 200 - 130 = 70.}$$

∴ Sides are 70, 80, and 50 miles.

General.

1. DUBITUM.—There is a translation in *Bohn's Series*, and also literal translations by Dr. Giles and Kelly.

2. A. S. M.—*Rushbrook's* 'First Greek Reader' is published by Messrs. Macmillan and Co., at 3s. 6d.

3. DESIROUS.—We cannot find 'King Robert' *with music*. The piece is in many collections of poetry.

4. SELF-HELPER may gain 'help' from *M'Laren's* 'Gymnastic Exercises,' Longmans, 2s.

5. RENEZEBE TONNEL.—
(*a*)

Sentence.	Kind of Sent.	Subject.	Predicate.	Object.	Extension.
O Heaven!		*Nominative Exclamatory*			
(*a*)					
That there were but a mote in yours, a grain, a dust, a wandering hair, any annoyance in that precious sense.	Noun sent. obj. to the sent. 'I wish.'	[That] a mote, a grain, a dust, a wandering hair, any annoyance in that precious sense	were but there in yours		
(*b*)					
Then your vile intent must needs seem horrible [to you] feeling	P. S. co-ordinate with '*I wish.*'	your vile intent	must needs seem horrible [to you] feeling		then (time)
(*c*)					
What small things are boisterous there.	Noun sent. to *feeling* in (*b*)	What small things	are boisterous there		

(*b*) Your small-hand is very good. Your text-hand is not so good, some of the curves being imperfectly formed. The capital is the poorest letter.

6. WM. AGER.—There is no reason whatever to believe that bad answering on Latin or French causes loss of marks on the other subjects.

7. DOROTHY.—Your writing wants firmness. It has the excellent quality of legibility; percentage about 75. Dont write *yours* with an apostrophe.

8. MACBETH.—The entrance fee is not uniform, but it includes instruction, food, and lodging. Write to the secretary of the College you would like to enter, and you will receive all the information you require.

9. CAITHNESSIAN.—We think you will be allowed to sit. Apply. Your writing is not good. It is uneven; some of the letters are formed well, some badly. It might carry 60 per cent.

10. ANXIOUS.—You have the query column at disposal. We fear what you want would require too much space. The number who need the help you speak of is now much smaller than it used to be.

11. ALEXANDER.—Small books; 'History of Greece,' 1s.; and History of Rome, 1s., in the series of Primers by Macmillan; larger books, *Smith's* 'Smaller Greek and Roman Histories,' 3s. 6d. each (Murray); also *Smith's* 'Histories of Greece and Rome,' 6s. each (Murray). The small-hand is good, worth perhaps 75; the text-hand is poor, would not get more than half the marks obtainable.

12. ASPIRANT.—*Dr. Casey's* 'Euclid' is published by Longmans, Green and Co.; Elements, 4s. 6d.; Sequel, 3s. 6d.

13. VERITAS.—What subject do you refer to, and what progress have you made in it already?

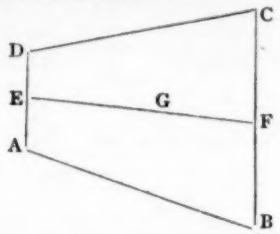
14. REFORM.—We should think 85.

15. ITHON.—It is excellent as to legibility, but it needs finish. The strokes are ragged, the curves are not graceful. There is no arithmetic in the 2nd year's course. If arithmetic is taken it must be the first year's paper.

16. TROUBLED ONE.—The questions set to the first and second years' students are published every year, and may be obtained at the Government Offices, Harding Street, Fleet Street, E.C. The price is 6d.

17. M. H.—You have worked the question *correctly*, and the answer is 10 per cent. loss. According to the rate of exchange (25 francs 20 centimes for £1) the value of a napoleon is 15s. 10$\frac{9}{11}$d. and not 15s. 8d.

18. A PUZZLED ONE.—The following is the rule for finding the centre of gravity of a trapezoid :—



Let ABCD be a trapezoid, AD being parallel to BC. Bisect AD, BC in E, F, and join E, F.

Let G denote the centre of gravity of the trapezoid.

$$\text{Then, FG} = \frac{\text{EF}}{3} \cdot \frac{2\text{AD} + \text{BC}}{\text{AD} + \text{BC}},$$

$$\text{Or, EG} = \frac{\text{EF}}{3} \cdot \frac{2\text{BC} + \text{AD}}{\text{BC} + \text{AD}}.$$

19. CUPIDUS DISCENDI.—The solution of your query appeared in our issue for April, 1884.

20. T. HARRIS.—Your query was solved in our issue for August, 1882.

21.—CANDIDATE.—Irregular as to size, neither straight nor symmetrical, and joinings wretchedly bad. 65.

22. LADY MACBETH.—All the long strokes require straightening; the length of stroke is also irregular. Get Mulhaüser's system, and study it. See 35.

23. CLERK OF THE HOUSE.—It has some excellent characteristics. The letters *e*, *r*, and *g* should conform to the recognised type.

24. THE CAULD LAD.—Small hand 80, large 60.

25. X.—Your writing is of a good, useful order for teaching purposes. 80.

26. BEAUPÈRE.—The large hand is decidedly too upright; it should rest at an angle of 60° with the horizontal. The small hand is excellent.

27. VERDANT GREEN.—Large hand is too large, and the small hand too much spread out. Down strokes of the small hand especially should be more even in thickness.

28. ROGO.—Small hand is written with side of pen. Hence lower curve is thicker than the downstroke, and the upper curves are pointed. The regularity and general style are good, as is also the large hand. Tracing not allowed; percentage 80. The use of the word is a matter of taste; we think the use of it is customary and justifiable.

29. MOT KCIWDAHC.—(1) Your query was solved in our issue for March, 1882. (2) Your specimen writing is *pretty fair*.

30. ALICE.—You will obtain the correct signs by the following methods :—

$$\begin{aligned}(1)\ (a+b-c)^2 &= \{(a+b)-c\}^2\\ &= (a+b)^2 - 2(a+b)c + c^2\\ &= a^2+2ab+b^2-2ac-2bc+c^2\\ &= a^2+b^2+c^2+2ab-2ac-2bc.\end{aligned}$$

$$\begin{aligned}(2)\ (a-b+c)^2 &= \{(a-b)+c\}^2\\ &= (a-b)^2 + 2(a-b)c + c^2\\ &= a^2-2ab+b^2+2ac-2bc+c^2\\ &= a^2+b^2+c^2-2ab+2ac-2bc,\end{aligned}$$

$$\begin{aligned}(3)\ (a-b-c)^2 &= \{(a-b)-c\}^2\\ &= (a-b)^2 - 2(a-b)c + c^2\\ &= a^2-2ab+b^2-2ac+2bc+c^2\\ &= a^2+b^2+c^2-2ab-2ac+2bc.\end{aligned}$$

Or,

$$\begin{aligned}(1)\ (a+b-c)^2 &= a^2+b^2+c^2+2(a\times b)\\ &\qquad +2(a\times -c)+2(b\times -c)\\ &= a^2+b^2+c^2+2ab-2ac-2bc.\end{aligned}$$

$$\begin{aligned}(2)\ (a-b+c)^2 &= a^2+b^2+c^2+2(a\times -b)\\ &\qquad +2(a\times c)+2(-b\times c)\\ &= a^2+b^2+c^2-2ab+2ac-2bc.\end{aligned}$$

$$\begin{aligned}(3)\ (a-b-c)^2 &= a^2+b^2+c^2+2(a\times -b)+2(a\times -c)\\ &\qquad +2(-b\times -c)\\ &= a^2+b^2+c^2-2ab-2ac+2bc.\end{aligned}$$

31. DENNY, Leamington.—*Hamblin Smith* has not published a Key to his 'Exercises on Algebra.'

32. H. J. W.—The equations to 3 circles are :—

(α) $y^2+x^2=3$,
(β) $x^2+y^2-6x-10y+25=0$,
(γ) $x^2+y^2-4(4x+y)+52=0$.

Show that the line joining centres of (α) and (β) is perpendicular to that joining (β) and (γ). (*L. C. P. Exam.*, 1882.)

(α) $y^2+x^2=3$;
∴ Co-ordinates of centre are 0, 0.

(β) $x^2+y^2-6x-10y+25=0$
$x^2-6x+y^2-10y+25=0$
$(x^2-6x+9)+(y^2-10y+25)=9$
$(x-3)^2+(y-5)^2=9$;
∴ Co-ordinates of centre are 3, 5.

(γ) $x^2+y^2-4(4x+y)+52=0$
$x^2+y^2-16x-4y+52=0$
$x^2-16x+y^2-4y=-52$
$(x^2-16x+64)+(y^2-4y+4)$
$=-52+64+4$
$=16$
$(x-8)^2+(y-2)^2=16$;
∴ Co-ordinates of centre are 8, 2.

Equation to the line joining two points :—
$(x_2-x_1)(y-y_1)=(y_2-y_1)(x-x_1)$
∴ Equation to the line joining the centres of (α) and (β) is :—
$(3-0)(y-0)=(5-0)(x-0)$
$3y=5x$
$\therefore y=\frac{5}{3}x.$

∴ Equation to the line joining the centres of (β) and (γ) is :—
$(8-3)(y-5)=(2-5)(x-3)$
$5(y-5)=-3(x-3)$
$5y-25=-3x+9$
$5y=-3x+9+25$
$=-3x+34$
$\therefore y=-\frac{3}{5}x+\frac{34}{5}.$

The line $y=\frac{5}{3}x$ is perpendicular to the line $y=-\frac{3}{5}x+\frac{34}{5}$.

Note.—Sparkes' work on 'Conic Sections' is the simplest (Stewart and Co.), but *Todhunter's* is the best.

33. SAUVAGE.—A tube, 1000 feet long, is filled with oxygen gas. Find how quickly the sound of a pistol shot will travel from one end of the tube to the other, it being given that the density of oxygen is 16 times as great as that of hydrogen, and that the velocity of sound in hydrogen is 4200 feet per second. (*Science and Art Examination.*)

Velocities of sound in gases are to each other inversely as the square roots of their densities.

∴ Velocity of sound in oxygen $=\frac{4200}{4}$ ft. per sec.
$=1050$,, ,, ;
∴ Time for sound of pistol shot to pass down the tube $=\frac{1000}{1050}$ sec.
$=\frac{20}{21}$ sec. Ans.

34. B. PARTINGTON and SIGMA.—We cannot obtain the solution by the hints which are given.

35. REGINA.—*McLeod's* Series, first six books. Writing is legible, letters irregular and badly formed; as a whole the writing lacks neatness and finish. 60 per cent.

36. FIDUS ACHATES.—Peculiarities of 'Richard II.' are archaic forms of language, words now obsolete, differences of structure, infinitives for preposition and gerund, use of verbs as both transitive and intransitive, where they are now only one or the other, elliptical expressions, omissions of the nominative-relative, and many anachronisms.

37. PETIT MAÎTRE.—It would take a page; a few interesting facts respecting his life and works can be found in 'Men of the Time,' page 734.

38. S. B. V.—There is no small book on Mental Science we can recommend for your purpose. The papers in the PRACTICAL TEACHER are to the point. Prof. Sully's new work 'Outlines of Psychology' will be the standard work on the subject for years to come. Read 'Lectures on Teaching' by J. G. Fitch, Esq.

Mensuration.

1. P. T.—A cubic foot of gold is hammered out so as to cover an area of 6 acres; find the thickness of the gold in decimals of an inch, correct to the first two significant figures. (*Cassell's* 'Saturday Journal.')

$$6 \text{ acres} = (6 \times 4840 \times 9) \text{ sq. ft.}$$
$$= 261{,}360 \text{ sq. ft.}$$
$$\therefore 261{,}360 \text{ sq. ft.} \times \text{Thickness} = 1 \text{ cub. ft.}$$
$$\text{Thickness} = \frac{1}{261360} \text{ ft.}$$
$$= \frac{1}{21780} \text{ in.}$$
$$= \underline{.000045\ldots \text{in.}} \quad \text{Ans.}$$

Note.—*Cassell's* 'Guide to Civil Service' (Cassell's), price 2s. 6d.; *Johnston's* 'Civil Service Guide' (Longmans'), price 3s. 6d.

2. CARN BREA.—The length and breadth of a rectangular room are measured with a defective foot-rule; the area appears to be 420¼ sq. ft., but is really 400 sq. ft. Find the error in the rule. (*P. T. Course.*)

$$\left(\frac{1 \text{ ft.}}{\text{Length of rule in ft.}} \times \text{Length of room in ft.}\right) \times \left(\frac{1 \text{ ft.}}{\text{Length of rule in ft.}} \times \text{Breadth of room in ft.}\right) = 420\tfrac{1}{4} \text{ sq. ft.}$$
$$\therefore \left(\frac{1 \text{ ft.}}{\text{Length of rule in ft.}}\right)^2 \times (\text{Length of room in ft.} \times \text{Breadth of room in ft.}) = 420\tfrac{1}{4} \text{ sq. ft.}$$

(But, Length of room in ft. × Breadth of room in ft. = 400 sq. ft.)

$$\therefore \left(\frac{1 \text{ ft.}}{\text{Length of rule in ft.}}\right)^2 \times 400 \text{ sq. ft.} = 420\tfrac{1}{4} \text{ sq. ft.}$$
$$\left(\frac{1 \text{ ft.}}{\text{Length of rule in ft.}}\right)^2 = 420\tfrac{1}{4} \text{ sq. ft.} \div 400 \text{ sq. ft.} = 1\tfrac{81}{1600},$$
$$\frac{1 \text{ ft.}}{\text{Length of rule in ft.}} = \tfrac{41}{40},$$
$$\therefore \text{Length of rule} = \tfrac{40}{41} \text{ ft.}$$
$$\therefore \text{Error in rule} = \tfrac{1}{41} \text{ ft.} \quad \text{Ans.}$$

3. F. HOLTON.—A square foot of paper weighed 104·68 grs., and when 320 figures had been written on it, it weighed 105·155 grs. If a strip of this paper 5¾ inches wide be taken to have written upon it the circulating period of $\frac{1}{198}$ which consists of 100102 figures, in two lines at rate of 5 figures to an inch, find the weight of whole.

$$\text{Area of strip} = \left(\frac{\overset{50051}{\cancel{198}\cancel{198}\cancel{198}}}{5} \times \frac{1}{\cancel{2}} \times \frac{23}{\cancel{4}}\right) \text{sq. in.}$$
$$= \tfrac{1181172}{360} \text{ sq. in.;}$$
$$\therefore \text{Weight of whole} = \left[\left(\frac{\overset{26{\cdot}17}{\cancel{198}\cancel{468}}}{1} \times \tfrac{1181172}{360} \times \frac{1}{\cancel{144}\ \ 36}\right) + \tfrac{1}{2}\{(105{\cdot}155 - 104{\cdot}68) \times \tfrac{100102}{360}\}\right] \text{grs.}$$
$$= \left(\frac{30126197{\cdot}41}{720} + \frac{\overset{\cdot095}{\cancel{\cdot478}} \times 50051}{\cancel{198}\ \ 32}\right) \text{grs.}$$
$$= (41{,}841{\cdot}9408472 + 148{\cdot}58890625) \text{ grs.}$$
$$= \underline{41{,}990{\cdot}529753472 \text{ grs.}} \quad \text{Ans.}$$

*** *Many Queries are unavoidably held over.*

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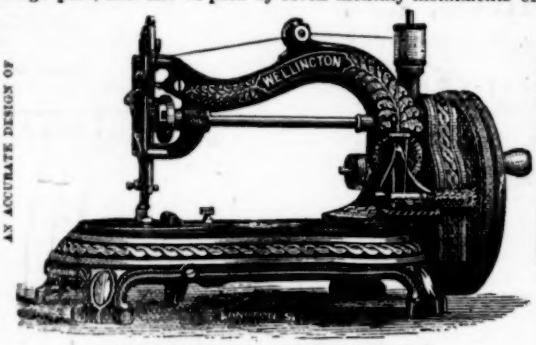

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